OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as "developed", "industrialized" and "developing" are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

19562

PREPARATORY ASSISTANCE FOR
THE ESTABLISHMENT OF PILOT
DEMONSTRATION FOUNDRY IN SYRIA
UC/SYR/89/241

TERMINAL REPORT

UNIDO Contract No 91/012 VK

29 GRANICZNA St
40 956 KATOWICE POLAND
TELEX 0315681
CABLE HPP KATOWICE
HUTMASZPROJEKT-HAPEKO
The Metallurgical
Project Engineering
& Consulting Co.

czubrpt

edited 23 December 1991
Final draft

PREPARATORY ASSISTANCE FOR THE ESTABLISHMENT OF PILOT DEMONSTRATION FOUNDRY

UC/SYR/89/241

SYRIA

UNIDO CONTRACT No 91/012 VK

Terminal Report

Prepared for the Government of Syria
by the United Nations Industrial Development Organization

TABLE OF CONTENTS

Acknowledgments 4

Abstract 5

Summary 6

A. Introduction

1. Background 9
2. Economic Management System 10
3. Current State of Foundry Industries 11
4. Major Aspects of Castings Production in Syria 12
5. Development Problems 12

B. Project Objectives 13

C. Discussion on Foundry Profiles 13

1. Criteria and Function 13
2. Foundry Capacity 14
3. Assortment of Castings 16
4. Choice of Production Programme 16
5. Location and Site of the Project 17

D. Financial Evaluation .... 18 - 23

1. Main findings ....
2. Assumptions of Financial Analysis ....

E. Conclusions 24

F. Recommendations 24

ANNEX 1 (pages 26 - 43)

Concept of Pilot Foundry ....

1. Technical Data on Foundry Building ....
2. Characteristics of Foundry Processes ....
3. Melting Section ....
4. Moulding Section ....
5. Core-making Section ....
6. Review of moulding and core-making techniques ....
7. Cleaning/Fettling Section ....
8. Laboratory ....
9. Patterns and Core-boxes ....
10. Raw materials ....
11. Training ....
12. Manpower ....
13. Pricing and Sales ....

Environmental Aspects ....

Safety Aspects ....

ANNEX 2

Financial Evaluation /Tables, Graphs/

APPENDICES /ATTACHMENTS/

1. Results of Marketing Studies ....
2. Outlines for Designing Pilot Laboratories ....
3. Conceptual lay-outs of laboratory sections ....
4. Draft Project Document ....
5. List of Reference Documents/Publications ....
6. Institutions visited ....
7. BCIRA Report ....
8. Note on SSRC; the counterpart ....
9. List of Tables ....
10. Foundry Lay-outs ....

Acknowledgments

The members of the UNIDO Team assigned to the project wish to express their gratitude to Dr. A.W. Chahid, President, the Director General, Scientific Studies Research Centre in Damascus and, also to his Staff whose hospitality and assistance extended to the Team made it possible to carry out all the project activities in accordance with the early agreed work-plan.

Effective collaboration with and active role both of Ms. M.Kallas and dr A. Bakkar, the counterpart, in joint actions and discussions undertaken within the frame of the project merits to be particularly appreciated.

Sincere thanks are addressed to Mr. Elias Salloum of the SSRC Public Relations Dept., whose help and guidance in the provision of necessary logistic services were indispensable.

ABSTRACT

A rapidly and constantly growing demand for castings in Syria mainly used for maintenance and operation of industrial enterprises and agricultural equipment has compelled the Government to investigate the existing potential of metal processing industries, and particularly, the foundry branch.

The problem of the underdeveloped basis for the manufacture of castings had been identified as particularly severe in the context of the current and perspective need to intensify the supply of diversified assortments of cast parts.

The Government has realized the complexity as well as various specific aspects of the problem and requested the UNDP and UNIDO for an advisory assistance of experts.

The study undertaken by the team of UNIDO experts sub-contracted from the HPH S.A. Ltd., a Polish Metallurgical Engineering and Consulting Co. has been focused on the question of establishment of a pilot demonstration foundry capable of manufacturing sophisticated castings and acting as a development centre for the existing foundry workshops and metal processing industries.

Two capacity alternatives have been analyzed, of outputs of 500 t/y and 1500 t/y respectively.

The programme of further UNDP assistance in this regard has been drafted and introduced in the form of a project document.

The programme is to be executed in 3 years.

Initial, pre-operational activities will be concerned with the detailed designs of the activities and the plant; the foundry itself is expected to be constructed and become operational within 2 years after starting the project execution.

The analysis of the PILOT DEMONSTRATION FOUNDRY shows that the project is financially viable, the 'net of tax' Internal Rate of Return on total investment is 21.94% and 36.01% respectively for 500 T and 1500 T of the two capacity alternatives and is well above the international standards of 12%. The payback period is of 4 years.

Unit costs appear satisfactory; labour costs constitute a surprisingly low percentage of total production costs; depreciation charges are high, cost of auxiliary materials relatively high. Net profits are positive as well as total cashflow. Dollar flow is consistently negative.

The profitability of the project is most sensitive to variations in sale prices and less to the volume of initial investment and operating costs. Proceeds from the laboratory services are not considered in the financial analysis.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Project background and objectives

Within the industrial sector of Syria the metal related industries including foundries are the least developed, while in general they have to be considered as the backbone of industrialization.

The country is aiming at changing this present situation, and in this respect aiming to expand and establish capital and intermediate goods industries in order to increase the production of machinery, spare parts and other production items required by especially the agricultural, construction and transport sector. This objective implies a strong reinforcement of the foundry sector.

For this reason the Syrian Government is planning to establish a pilot demonstration foundry (PDF), and asked UNIDO to make a preparatory study with the objective of reviewing the requirement for, and the viability of this PDF. This is to provide technical consulting and training services, and to be economically self sufficient through the sales of casting produce by the training and technology development and transfer activities. The study was prepared in cooperation with the Scientific Studies Research Centre in Damascus - SSRC (note on the counterpart attached).

Market survey

A market survey has been carried out to investigate the demand of quality castings and training and development activities in the foundry sector. The market survey was supplemented by statistical data sources and information collected from various industries through early distributed questionnaires. The state enterprises of the industrial sector create the bulk of the demand for quality castings. The private enterprises of this sector, except for machine shops and a few larger companies, play a minor role. [Table 1]

The potential market of castings is estimated at about 50.000 tons, with the major customers being the road construction sector, cement, sugar, chemical, fertilizers, food processing industries, mechanical workshops, agricultural engineering industries and other.

It is assumed that PDF will be able to attract up to 10% of the potential market of special, jobbing type castings of high alloy grades of which the demand estimated on about 2000 tons annually. [Tables: 2, 3, 4]

Considering the high quality standard of the proposed products of the PDF and the volume of the market available in Syria the outlet to the market is secure. The PDF will not compete within the market in Syria, ie., will not compete with local foundries.

In general, the quality of locally produced castings is poor, while the prices of locally produced parts are high as compared to the price of castings on the international market. The PDF will encounter most competition from imported products in marketing their output. Shorter delivery times, saving of foreign currency, flexibility and availability of good services to customers provide PDF some strong market advantages as compared to the imported castings and parts.

Market penetration is not expected to be too difficult. Pricing policy has to be market oriented rather than cost oriented.

Alternatives for PDF capacity

The study on the future project and its financial analysis have been carried out also in the context of alternative investment capital expenditures.

It was applied to the concept of PDF of the two capacity variants of 500 and 1500 tonnes.

The structure of production programmes was chosen as to give the priorities to steel castings of which an acute deficit was early confirmed by the marketing study. The production of grey iron castings (including ductile cast iron) complementary to steel castings has been only considered for PDF 1500. [Table: 4]

The financial analysis of the two alternative PDF variants provided equally encouraging results thus leaving the ultimate selection dependable on investment capital available.

Policy aspects

PDF's policy and activities should be in accordance with Syrian Government's development strategy.

The timely provision of raw materials and additives is of such importance that, taken into account the limited local market for these imported products, it is advised to create a small fund of foreign currency at the disposal of the PDF management.

In order to ensure the correct operational environment, and the continuity of the services the PDF will act as a non-profit, self sustaining enterprise with the management having its own responsibilities. In order to strengthen the management team it is advised to create a steering committee, which will advise the management.

In order to allow proper staff development, training (on the job and overseas), attractive wages and other salary incentives are important aspects. A radical increase on salary/incentives fund is expected to be made in the fifth year of operation i.e. when it is proposed that the PDF will be granted an independent financial and administrative status.

Training activities, product and process development and improvement activities have to be provided at either cost-price or no-charge basis during the first years. Special training and development programmes for the administrative section of the project seem not to be required.

Locally available systems for financial control, auditing and price calculation can be used.

Project Engineering

The design of the foundry depends to some extent on the nature and volume of the services to be provided, this influences the type of castings to be produced but the market is such as to present no restriction. For this a complete list of castings was analyzed and studied in detail. The analysis resulted in a selection of the quantity of patterns required, the moulding method and the core making method. Based on this the requirements for the production machinery and equipment, auxiliary equipment and service equipment have been determined. [Table 5] Also the quantities of raw materials required have been listed. [Tables: 6, 7] A laboratory will be installed at the PDF.

During installation and operation attention should be paid to environmental and safety aspects.

Physical facilities and equipment

Land is already available and will be assigned soon to the project. Lay-out suggestions have been prepared for site, foundry building and office buildings. Required investment costs for land, site preparation, buildings, infrastructure and machinery and equipment have been calculated.

Manpower requirements

The experts team recommends that the total number of personnel to staff the project will amount to 122 (PDF 500) and 145 (PDF 1500), of whom about 45% are directly production related. Relatively high salaries are recommended for the personnel, in order to be able to contract personnel of outstanding quality and to be competitive at the labour market.

As for expatriate experts, it is recommended to assign a UNIDO team working during the project period, consisting of a chief technical adviser (project coordinator) and an expert in pattern making, supplemented with experts on a short-term basis. Furthermore there will be a need for specific expertise, to be provided by various UNIDO short-term consultancies and Syrian consultants.

Training, service and development aspects

Product and process development activities during the first years of operation will aim at diversification and quality improvement of castings production.

Training is therefore considered a crucial and critical point of the project implementation. Several training programmes will have to be applied for about 50% of employees. [Tables: 8, 9]

Training activities will be focussed on more advanced fields of technical training, such as product and pattern design and production planning, induction melting and laboratory training. The first two years the training programme will have to concentrate on the requirements of own personnel, but in a later stage also supervisory, technical and management personnel from other foundries will be trained on-the-job at PDF. Objective standards will be created in order to measure the level of skills of trainees. Foundry operation will be trained on-the-job. The PDF is will provide consultancy services and technical assistance on a permanent basis for other foundries.

A detailed inventory of bottlenecks within the foundry sector and "emergency programme" of technical assistance has to be prepared during pre-operational phase of the project, in order that these receive attention during and after the implementation of the project.

Cost of the project

Total project costs covering international contribution and bank loan are estimated to amount of US$ 3.975 million and US$ 5.620 million respectively for PDF 500 and PDF 1500 and the local investment component SYP 50.561.600 (PDF 500) and SYP 72.600 million (PDF 1500).

Financial analysis

Results of the discounting methods of Net Present Value [NPV] before tax at 9% discount factor and Internal Rate of Return [IRR] after tax used for financial analysis indicate that the project is financial feasible; this conclusion applies to the two capacity alternatives namely:

(i) 500 T - IRR = 21.94%
(ii) 1500 T - IRR = 36.01%

The project will obtain a profit from year 2 onward of foundry operation.

Economic analysis

The project will make a positive contribution to:

- employment creation,
- integration of the national economy both within the industrial sector as through linkages with agriculture and infrastructure,
- saving of foreign currency and more local value added,
- more economic independence through import substitution,
- creation of Government revenues and stimulation of local entrepreneurship.

Quantitative analysis furthermore reveals that net savings in foreign expenditures will amount annually from about USD 600.000 (PDF 500) to USD 2.500.000 (PDF 1500), which is considerable.

It can be concluded that the project itself is expected to have an important contribution to economic growth and in this sense is very acceptable from a national economic point of view. Moreover, it is also expected that the project will have considerable spinoff effects, which have not been quantified in the economic calculation.

For this reason the experts team recommends to implement the project as soon as possible.

A. INTRODUCTION

A 1. Background

The picture which emerges from the information collected is that the industrial sector in Syria is comparatively well developing and contributing of about 30% of GNP. It is mostly composed of the following significant industries (industrial branches):

- chemical incl. fertilizers manufactures
- petrochemical
- cement
- textile
- food processing incl. sugar factories
- geological/mine and mineral processing
- building, industrial and general construction incl. roads and
- bridges construction
- means of transportation
- engineering/metal processing
- steel industry.

The concentration of most important production potential is found in Damascus, Aleppo, Latakia, Homs and their suburbs, where cement, food processing, fertilizer, petrochemical, building construction companies are operating apart from a large number of small-scale workshops of various profiles.

The existing status of engineering and allied metal working and steel processing industries reveals the following important findings namely:

- the input materials required are mostly imported from abroad; (a.o. castings, forgings, metal sheets, steel bars);

- the country has basic metal transformation facilities i.e. melting, rolling, casting, forging, etc. which are not developed to the extent adequate to the present state and future development plans of the country's economy;

- heat-treatment facilities exist in several workshops, however, their use is rather limited by production programme and technological requirement;

- most of the metal fabrication is directed towards cutting to shape and welding;

- the system of quality control applied by most of the workshops as well as the product quality requires to be improved;

- there is a strong tendency stimulated by most of the workshop technical staff to up-grade the level of manufacturing technology;

- the growing demand for castings is mostly met by the import of finished machine construction parts.

The PDF.

The need for a pilot demonstration foundry (PDF) has been detected by the Government; designed to support the development of the foundry industry in order to accelerate in turn, the development of industry and to consolidate efforts to improve the operation and maintenance of industry. A request has been forwarded through the office of UNDP in Damascus to UNIDO for a preparatory and investigative phase in order to properly analyze and quantify the needs and the inputs necessary to accomplish a proper self supporting pilot plant.

This report details the findings and views of the team of experts that visited Syria in the period of 25 April - 3 June 1991, covering marketing, technology, training, civil engineering and financial aspects.

In order to economize the time and simplify the communication with the staff of Syrian industries and Government institutions questionnaires in English and Arabic have been jointly prepared with the counterpart staff of SSRC. A number of questions related to statistical figures, standards, prices, etc., have been formulated (questionnaire attached).

The members of counterpart staff were designated to assist in the efficient and speedy collecting of necessary information and to provide input information on the conditions required to operate a foundry workshop.

Their knowledge of the foundry industry and product distribution proved invaluable and this was fully utilized in the preparation of this report.

A 2. Economic Management System

The Syrian economy operates until the present day within a centralized top-down planning framework, applied for most of the industry, which is Government owned or falls under public ownership scheme. Annual plans are determined for each enterprise.

Monetary and financial macroeconomic policy instruments play a subordinate role (prices, credit terms, exchange rates) in stimulating efficient allocation and use of resources. Prices of inputs (including labour) and outputs are determined centrally and have been stable for the past 10 years.

The overwhelming part of economic surplus produced at enterprises is channeled to the state budget. "Corporate taxes" (50%), depreciation fund is entirely paid into the central fund. On the other hand, bank loans are credited on 9% for investment purposes and 12% in case of short term loans.

Thus efficiency in production and investment is attempted through direct controls and administrative procedures rather than indirectly by means of economic parameters.

The accounting practices of the Syrian enterprises bear direct relationship to the overall economic system in force.

The most of small private foundries do not have any formal accounting system. Even in the larger firms, basic accounting registers planned costs and profits (normative coefficients of accumulation determined every year at higher level) decomposes into essential categories of basic and auxiliary materials, energy, depreciation, labour (with social security), shop overhead, enterprise overhead, non productive expenses, normative profits. Comparison against centrally established average standards is the only system exercised and no methods of evaluating production or marketing alternatives are practiced (or indeed, needed). Financial information and reporting leaves much to be desired at larger enterprises and is non-existent in small workshops. No control data is available in terms of cash flows even at the enterprise level (this is largely explained in frequent cases of foundries which do not constitute independent entities and pass on their castings for further processing or assembling to other departments).

In general, access to economic and financial information is not sufficiently easy for it to play a stimulating role in strategic and operational decision making.

A 3. Current State of Foundry Industries

Further development of the industry as a whole, in Syria will depend very much on the supply of castings and prompt up-grading of the foundry branch. Some 5.000 tons of cast semis a year, weighing between 0.5 kg and 1 ton each, are now produced in Syria. Of this quantity, about 80 per cent of castings are produced in green sand moulds made of sand and clay and hand rammed. The remaining castings are produced with the aid of moulding machines of jolting or squeeze-jolting type.

Pig iron and scrap are melted in cold-blast cupola or in induction furnaces. The charge is prepared and loaded essentially by hand. Pouring the molten metal is also a manual operation. Cast steel is melted in induction and arc furnaces with a throughput of 0.3 - 1.5 t/h. In case of heavier castings the molten metal is poured by means of crane ladle rather than by hand.

All other labour-intensive processes are performed by non mechanized means. The state of the foundries does not, as a whole, meet modern requirements and cannot offer the essential support, urgently required for the development of mechanical and engineering industries in the immediate future.

There are two relatively large-scale foundries in the town of Aleppo established in the current decade; one operating under a joint venture agreement by AL-FRAT Co. is located in the Tractor and Agriculture Machinery Plant and the other, a Steel Foundry is run under private ownership.

The manufacturing processes in the AL-FRAT Foundry are almost wholly mechanized; there are also modern pattern-making and laboratory facilities, not regularly utilized.

Moreover 2 medium-scale foundries are located in Damascus; they are run by the largest national multi-branch corporation "MILIHOUSE". A few vocational schools exist in the country; they implement a training programme under the outlines of the Ministry of Education and Ministry of Industry . Conventional obsolate techniques are demonstrated are small foundry shop is now used for artistic castings.

The overall annual output of the foundry industry in the country in 1991 was expected to reach about 5.000 tons of mostly cast iron.

Most of the foundries are equipped with simple pattern-making equipment but rarely with laboratory facilities, the available laboratories are occasionally utilized to test the properties of moulding sands and/or to determine the chemical composition of cast steel.

The production of castings is of standard type (ALEPPO) with a very limited number of jobbing orders.

Most of the operations are carried out manually using obsolete techniques and tools.

Almost no process design activities directed towards up-grading the foundry operations have been undertaken.

Absence of adequate number of qualified technical cadres in the foundry industry along with a poor laboratory basis make it impossible to implement any R and D programme at present.

A 4. Major Aspects of Castings Production in Syria

Consequences of the above-described state of the foundry industry can be summarized as follows:

(i) acute deficit of cast parts and cast elements estimated in the whole of the national economy at over 50.000 tons/year is almost entirely covered by the growing import;

(ii) low and limited production capacity of the existing foundry-workshops;

(iii) inefficient work-methods and processes employed by most of the foundries;

(iv) low degree of mechanization of foundry operations;

(v) lack of quality standards and appropriate quality control procedures normally applied by castings manufacturers;

(vi) absence of advanced training centre(s) and appropriate regular programmes for up-grading the skills of foundry personnel;

(vii) lack of R and D facilities normally required to develop and implement the design of prototype castings and related pilot (experimental) foundry technologies.

A 5. Development Problems

The development problems have been identified as follows:

(i) at the country level

A rapidly growing demand for cast parts particularly spares caused by import of new machines and equipment and increasingly diversified range of maintenance (machine repair) services.

(ii) at the sectoral level

An urgent need to upgrade the skills and qualifications of the manpower engaged in the manufacture of castings.

B. PROJECT OBJECTIVES

B 1. The immediate objectives of this present preparatory assistance project are to obtain:

- a market analysis for castings to be manufactured by a Pilot demonstration foundry (PDF)

- a detailed work programme for the establishment of the Foundry with an integrated Pilot Laboratory

- a financial analysis of the foundry operation and to indicate the volume of future financial inputs which may be required

- the project document on establishment of a Pilot Foundry Workshop.

B 2. The development objective of the project is to improve the efficiency of the operation of industry by increasing the supply of castings and to accelerate the increase of the country's share in the supply of cast spare parts.

This refers, in particular, to the castings in heavy demand by the industry as a whole, and also to cast spare parts needed by the agricultural sector, and expected to be manufactured by means of appropriate, modern foundry processes.

The development objective is fully reflected in and corresponds to the national development strategies which are to be incorporated in UNDP documents of the forthcoming Country Programme.

In conformity with the objectives and strategies of the National Development Plan, the Government has decided to give high priority to technical co-operation in the fields of agriculture, industry, energy and mining. Several missions, surveys and sectoral studies were conducted to identify the specific technical assistance needs of those sectors.

These studies have been instrumental in the identification of areas in which technical co-operation is urgently required in furtherance of the major objectives of the Plan. As a result, the Government has described priority requirements for technical cooperation as:

(a) introducing new technologies in the various sectors of the economy;

(b) building up skilled labour, particularly at the intermediate/subprofessional level through education and training;

(c) attending to constraints and bottlenecks in various sectors through high-level expertise and short-term consultancies;

(d) improvement of industrial production among other through acquisition of advanced overseas techniques.

C. DISCUSSION OF FOUNDRY PROFILE

C 1. Criteria and function

The criteria for selecting the profile of a pilot demonstration foundry established by UNIDO and SSRC were the basis of studies undertaken by the experts. These criteria were understood as pre-conditions of a follow-up project and, on the other hand, as the guidelines for pre-feasibility study needed to identify the investment capital requirement; these were formulated as follows:

- the foundry will perform the function of a pilot unit designed to offer technology transfer and technical consulting services, and advanced, on-the-job training for supervisory, technical and management staff from other workshops, and will be financially self-supporting through the sale of castings produced in the training programmes.

- the production capacity (annual output) of the foundry will depend on: firstly, the intention to ensure that the foundry be financially self supporting in order to permit the provision of the above mentioned services at a price which is within reach of the Industry. The capacity will also depend upon the investment capital available. It is noted that the demand for castings is far above the local capacity and the demand is thus not a limiting factor.

Additional activities of the Foundry have been defined as follows:

(a) to serve the industrial community as a source of commercial quality, prototype castings;

(b) to provide the engineering, and technical consulting and testing facilities to assist other foundries in solving problems of quality, production methods and materials. The foundry will develop and demonstrate the application of appropriate techniques and technologies for producing high-grade castings;

(c) to produce special or critical castings intended for the maintenance of imported equipment, and to transfer the processes to other plants;

(d) to serve as the source of technically trained foundry engineers and managers as well as skilled technicians, such as supervisory and advanced operational personnel, and laboratory and quality assurance staff. To realize this goal, the PDF should operate regularly scheduled training courses of both the practical and theoretical aspects of foundry techniques;

(e) to serve as a standardizing agency for establishing purchasing specifications for all locally produced or imported production materials and for establishing inspection procedures to ensure consistency in the quality of castings designed as spare parts;

(f) to collect and disseminate regularly all available data and technical information to the local foundries and to assist in updating practices and improving the product;

(g) to serve as a consulting, testing and control laboratory for the casting users and the foundry industry.

To perform such multipurpose tasks, the pilot demonstration foundry (PDF) must have the support of established Governmental organizations engaged in engineering, trade and education, as well as of agencies concerned with the industrial development of the country, and of local industrial management organizations.

C 2. Foundry capacity

The figures related to capital requirement shown in a comparative manner in Table No 10 - "Comparison of capital expenditure" are applicable in conditions prevailing in most of the European countries. Costs of land and site preparation are not considered.

Table No 10

COMPARISON OF CAPITAL EXPENDITURE
(indicative - comparative figures)*

DESCRIPTION	500 TONS US $	1000 TONS US $	2500 TONS US $
1. Technical documentation	70.000	140.000	150.000
2. Consultants/Experts	384.000	705.000	850.000
3. Civil engineering works. Preparation of the project site**. Industrial infrastructure. Foundation and construction of the building. Erection of the building.	375.000	650.000	800.000
4. Training programmes:			
- fellowships for engineers	108.000	108.000	240.000
- on-the-job training of operators	54.000	110.000	120.000
5. Technological equipment including its assembly and in-run tests	840.000	1.200.000	2.000.000
6. Auxiliary and infra-structural equipment (pumps, tanks, compressors, transformers)	250.000	350.000	500.000
7. Locally fabricated equipment and tooling	50.000	200.000	150.000
8. Patterns and related equipment and tools	30.000	50.000	150.000
9. Imported raw materials (6 month supply)	50.000	80.000	150.000
10. Transportation means (vehicles, mini-bus, trucks)	30.000	50.000	70.000
11. Commissioning of foundry equipment and production lines	144.000	168.000	240.000
12. RESERVE (Contingencies)	115.000	189.000	230.000
13. TOTAL	2.500.000	3.000.000	5.650.000

* Excluding other items of working capital.

** Subject to the local prices of building materials labour costs etc.

A comparative analysis of investment capital needed to establish three pilot foundry workshops of different production capacities and various manufacturing programmes has resulted in the following approximate figures:

		Investment required*
(i) Grey iron foundry: output 500 t/year, regular production of medium intricate shape castings	-	US $ 2.500.000
(ii) Steel foundry: output 1000 t/year product mix: regular production of light and medium weight castings plus prototype cast parts	-	US $ 3.000.000
(iii) Foundry plant: output 2500 t/year iron and steel castings of regular production.	-	US $ 5.650.000

The relation between the investment capital and production output of each of the three foundries shows that the cost per ton of sound castings is decreasing as the capacity installed (annual output) of the foundry under consideration grows, namely:

	Capacity		Unit investment cost
(i)	500 tons/year	-	US$ 5000/ton
(ii)	1000 tons/year	-	US$ 3000/ton
(iii)	2500 tons/year	-	US$ 2260/ton

* in convertible currency

C 3. Assortment of Castings (product mix)

The project concept recommended for further detailed design is based on present consumption of iron and steel castings by the leading Syrian industries and corporations and on the estimated demand after 1991. (Table 1)

Several essential technological factors (and constraints) such as casting application, castings shape, intricacy of surface, type of material (cast alloy), quantity, shape and position of cores (in the moulds), quality requirements etc. have been taken into consideration while drafting the production programmes of the PDF 500 and 1500. Some standard characteristics are given in tables 11, 12, 13, 14.

A 4. Choice of the Production Programme

The Foundry with an integrated laboratory is expected to be a financially self-sufficient unit operating without Government subsidy, once full capacity has been attained.

In this context, the castings assortment proposed to be manufactured [Tables 15, 16, 17] ought to be carefully chosen taking into consideration several important factors having a direct impact on successful performance of the PDF, namely:

- the utility to the Foundry Industry, of the technologies required for the manufacture of the castings, and which will be transferred to the industry;

- the urgency of the requirement of the national economy for the supply of the casting selected;

- guarantee of satisfactory financial results, yielding the income necessary for the continued operation of the PDF and the provision of the services specified;

- smooth adoption of modern foundry equipment and techniques and their efficient use by staff and workers who will receive much of their training within the PDF.

In view of the above factors, the programme proposed for implementation has been supported by the following arguments:

(a) higher valu^ of steel castings vis-a-vis grey or common alloy cast parts', and the requirement for more advanced metallurgical knowledge;

(b) castings groups of moderate shape intricacy, relatively easy to be manufactured, have been included into the programme;

(c) expected further growing deficit of steel castings after 1991

(d) growing demand for "fast moving" cast spare parts justifies a stable and regular production in the future;

(e) additional financial income derived from the laboratory testing needed among other to issue quality certificates for some special or heavy-duty casting;

(f) import substitution particularly of alloy steel castings manufactured on jobbing or short series (batch) production orders at a comparatively high value added;

(g) income to be derived from the development of the production of prototype cast spare parts and the related documentation.

C 5. Location and Site of the Project

Two locations had been proposed by the counterpart in the Adra region located about 40 kms from Damascus and have been considered by the team:

a) in the industrial zone in a close neighbourhood of the Power Station under construction and, near the railway connecting Damascus with the northern region of the country;

b) in another industrial area of over 50 hectares situated about 5 kms north of the Adra Cement Factory and about 2 kms from the Damascus railway.

The two sites are situated in the areas reserved by the Government for industrial development.

The following factors affecting site selection have taken into consideration:

- market outlet,

- pilot (experimental) profile of PDF production servicing other foundries,

- training and links with vocational schools, technical universities, R/D centres etc.,

- labour availability,

- infrastructure on site,

- transport (railway, roads),
- waste disposal,
- cost of site preparation,
- availability of energy, water, gas.

The two sites present almost similar features; the final selection will depend on results of soil tests and further investigation of geological pattern.

The adjacent power plant under construction and railway connection will reduce the cost of infrastructure in case the site under para "a" is selected.

D. FINANCIAL EVALUATION

D 1. Main findings of the analysis

The financial appraisal of the two capacity alternatives of the project encompasses the main type of activity consisting in the production and sale of cast spare parts destined for the internal Syrian market. The operation of the laboratory is also included in the calculations.

The summary results are as follows (in thousands of SYP):

Net present value and internal rates of return

	PDF 500	PDF 1500
a) Equity paid versus Net income flow:		
Net present value	252.639.00 at 9.00%	747.555.30
Internal Rate of Return (IRRE1)	145.23%	192.33%
b) Net Worth versus Net cash return:		
Net present- value	247.926.40 at 9.00%	724.293.30
Internal Rate of Return (IRRE2)	159.53%	192.67%
c) Internal Rate of Return on total investment:		
Net present value	195.869.80 at 9.00%	668.565.20
Internal Rate of Return (IRR)	21.94%	36.01%

Net Worth = Equity paid plus reserves

The rate of return on total investment is rather high and amounts to 21.94$ and 36.01 [PDF 500 and 1500]. It satisfies standard internationally accepted requirements for investment efficiency. Given the discount rate adopted for the present study (9%) it is well above the minimum level.

The rate of return on equity as measured by net income flow is very high [145.23% and 192.33%] as well, and shows, that the venture is worth undertaking from the commercial point of view (i.e. profits are positive and dividends are to be expected).

Return on equity as measured by net annual cash flows [159.53% and 192.67%] testifies additionally that the project generates enough cash to be self-financing in respect of all the envisaged current activities.

The ratio of net income on total sales is stabilized at a healthy level exceeding 20 and 30% annually respectively for PDF 500 and PDF 1500 after tax: e.g. 27.17% in 1995, 23.46% from 2001 for PDF 500 and 32.32% in 1993 and 31.97% from the year 2000 for PDF 1500; (see Table NET INCOME STATEMENT of Appendix). Net profit on total investment amounts accordingly to just under 15% and 31%. Net annual profit achieved is therefore around 35 and 105 million Syrian Pounds during a normal year of operation which appears to be entirely satisfactory. It is important to note that profits are positive from the first and second years of production.

All production years bring positive net cashflows confirming the sound foundation for the whole venture. Cash balance (i.e. the amount of cash available for the enterprise at any given moment assuming full self-financing) behaves in a similar manner.

The payback period as measured by the cumulated net cashflow stands at 4 years including the start-up period (excluding the investment period of 2 years).

The fixed costs coverage ratio showing how many times the variable margin exceeds fixed costs is around 2. This testifies to high degree of security of the project in this particular respect.

Unit costs for a normal year of production stand at around 281.1 and 219.3 thousand Syrian Pounds per ton of good castings. This is inside the current price of raw castings in Syria.

Sensitivity analysis has also been performed with various assumptions concerning upward and downward movement of sales prices and production costs. The results of calculations are given below:

Table No 18

Sensitivity analysis: Internal Rates of Return (in %)

	PDF 500	PDF 1500
Base case	21.94	36.01
1. sales prices down 10%	16.43	30.17
2. sales prices down 20¦%	9.5	22.00
3. sales prices down 30%	0.84	14.30
4. sales prices up 10%	26.73	41.22
5. operating costs up 10%	19.68	34.35
6. operating costs up 20%	17.23	32.62
7. operating costs up 48%	8.77	27.29
8. investment costs down 10%	24.51	39.32
9. investment costs down 20%	27.7	43.00
10. investment costs down 40%	36.21	54.23

The results of the analysis indicate that the overall profitability of the project is most sensitive to changes in the prices of output. The overall profitability appears relatively insensitive to the variations in local factory costs. This is also due to high depreciation rates included in production costs.

As 100% of the output of the project is destined for the internal market, the project carries dollar deficits amounting to 23.2 (PDF 500) and 81.8 (PDF 1500) million SYP largely on account of raw materials and spare parts.

However, only the convertible currency cashflows are shown to be in the negative in the tables of the Appendix .

All calculations have been made under the assumption of the exchange rate of 1US $ = 43 Syrian Pounds.

Constant prices have been assumed all throughout the calculations given the difficulty of arriving at a reasonable estimate of inflation in several different countries.

All financial calculations have been carried out with the help of the Computerized Model for Feasibility Analysis and Reporting (COMFAR), being at the disposal of UNIDO Investment Promotion Service in Warsaw, for which all rights are reserved by UNIDO, Vienna. All the complementary calculations are shown in the text and tables.

The text of the report does not contain any elements of the appraisal from the national economic point of view (social cost benefit analysis according to the UNIDO methodology or using the value added method) since it goes beyond the strictly financial evaluation.

D 2. Assumptions of Financial Analysis

The present section contains additional detailed information concerning the assumptions made in the calculations.

(a) Initial Fixed Investment

For the purpose of financial analysis, the initial investment period has been assumed to be 2 years. The total funds earmarked for the project stand at 3.975.000 US$ and 50.561.600 Syrian Pounds (PDF 500) and USD 5.620.000 along with Syrian Pounds 72.600.000 (PDF 1500).

It has been assumed that about 17% of the outlays is made during the first year and 75.5% during the second year of each phase of investment. The remaining 7.5% is to be spent for purchasing laboratory equipment during second year of operation.

The price of land has been taken as nil.

All the assets financed from the Syrian side contribution are depreciated. From the UNDP contribution. only laboratory equipment is depreciated; training, commissioning, travel, etc. costs are subsumed under grants.

The depreciation rates respect the regulations in force in Syria.

Depreciation rates:		
	buildings	4%
	machinery	6%
	incorporated assets	20%
	infrastructure	4%
	land	0%

(b) Projection of Sales (Tables: 19, 20, 21)

Production capacity is assumed to be utilised at the level of:

PDF 500		PDF 1500
38%	during the first year of production	25%
57%	during the second year of production	32%
75%	during the third year of production	56%
90%	during the fourth year of production	77%
100%	during the latter years.	100%

(c) Structure of production costs during the 5th year (full capacity utilization):

Table No 2

	PDF 500	PDF 1500
Raw materials	28.7%	38.5%
Utilities, energy	4.1%	5.5%
Labour	32.6%	25.7%
Maintenance	3.3%	2.2%
Spare parts	2.8%	1.9%
Factory overheads	6.1%	4.5%
Depreciation	10.5%	10.7%
Interest	11.9%	11.0%

The following assumptions have been made for the project:

(a) The average percentage of rejects is 20% during first two years of production and 15% during the latter years.

(b) It is assumed that the project will be exempted from any duties on imported equipment and materials.

c) Labour cost has been increased three times starting from 5th year of production (first year of full capacity utilization) to make project closer to world market conditions.

(d) Calculation of Working Capital

The following assumptions have been made:

	Coverage in days Foreign	Local
a) Accounts receivable	30	30
b) Cash in hand	0	3
c) Inventory principal materials	180	5
d) Inventory other materials	180	5
e) Inventory spare parts	180	30
f) Inventory energy	0	1
g) Inventory utilities	0	3
h) Inventory work in progress	10	10
i) Inventory finished products	3	3
j) Accounts payable	30	30

The working capital requirement is, on average, with full use of the capacity, around 15.2 and 31 million Syrian Pounds, respectively for PDF 500 and PDF 1500.

(e) Sources of funds

Table No 23

Investment and sources of total required finance
(thousand Syrian Pounds)

PDF 500

fixed assets:	218.131.50	76.88% foreign
current assets:	3.395.00	96.125% foreign
total assets:	221.486.50	77.172% foreign
equity + grants:	74.211.50	92.708% foreign
foreign loans:	102.125.00	
local loans:	45.150.00	
total funds:	221.486.50	77.172% foreign

The following assumptions have been made for the necessary financing the project:

1) foreign loan (mainly for machinery and equipment)

- total amount 2.375 mln US$
- grace period 2 years
- amortization period 5 years
- interest rate 13%

2) local loans

- total amount 45.150 mln Syrian Pounds
- grace period 2 years
- amortization period 5 years
- interest rate 7.5%

3) SSRC equity in total amount of 5.411.5 thousands Syrian Pounds.

PDF 1500

fixed assets:	287.592.50	74.160% foreign
current assets:	4.500.00	96.556% foreign
total assets:	292.092.00	74.490% foreign
equity + grants:	87.312.50	88.647% foreign
foreign loans:	140.180.00	
local loans:	64.600.00	
total funds:	292.092.00	74.790% foreign

Assumptions for the necessary financing of the projects:

1) foreign loan (mainly for machinery and equipment)
   - total amount 3.820 mln US$
   - grace period 2 years
   - amortization period 5 years
   - interest rate 13%

2) local loans
   - total amount 72.600 mln Syrian Pounds
   - grace period 2 years
   - amortization period 5 years
   - interest rate 7.5%

3) UNDP grant in total amount of about 1.9 mln US$ mainly for training, commissioning of the factory and equipment for laboratory.

4) SSRC equity in total amount of 9.912.5 thousands Syrian Pounds.

(f) Income Tax

Income tax is assumed to be 50% starting from 6th year of production according to the present regulations. The IRR stands at 21.94% with the NPV of over 195 million Syrian Pounds. The project is thus very profitable.

All the calculations have been carried out for the calendar years.

The discount rate has been set at 9%. It is extremely difficult to estimate the cost of capital in Syria (no economic analysis in terms of shadow pricing has been done). The current interest rate on long term credits stands at around 7.5 per annum, with a long grace period up to 2 years. The interest rate on short term loans is 9%.

E. CONCLUSIONS

E 1. The technical level of the Syrian foundry Industry is low; the services to be provided by the PDF will be an essential support for it's rapid development. The market for training, technical assistance and technology transfer are well defined.

E 2. The production of castings (cast spare parts) is essential for the Syrian economy. Given very high current imports, the market outlet is assured and the PDF will not represent competition to the local foundry industry. The capacity envicaged for the PDF economic/financial point of view. Significant linkages with other metal processing branchas are expected.

E 3. The analysis of the Pilot Demonstration Foundry shows that the project is financially self supporting, the net of tax Internal Rate of Return on total investment is 21.94% and is well above the international standards of 12%. The payback period is of 4 years.

E 4. Unit costs appear satisfactory; labour costs constitute a surprisingly low percentage of total production costs; depreciation charges are high, cost of auxiliary materials relatively high. Net profits are positive as well as total cashflow. Dollar flow is consistently negative to the project (but positive to the economy).

E 5. The profitability of the project is most sensitive to variations in sale prices and less the volume of initial investment and operating costs. Proceeds from the laboratory services are not considered within the financial analysis, and are not essential to the viability of the PDF.

E 6. Comprehensive, intensified training of technical staff and operators, in particular, of the operators of maintenance services of sophisticated electronic equipment/automatic lines, special tooling, etc. is considered imperative for the effective running of the proposed pilot foundry and its laboratory.

E 7. the training programme which is designed to be carried out abroad will be exposed to major risk if it cannot be successfully completed on time or not undertaken at all due to e.g. recruitment difficulties or selection of non-acceptable candidates. language deficiency, improper co-ordination of preparatory actions by the project national staff, etc.

E 8. In case the training is delayed or incomplete it will have a serious negative impact on the smooth starting-up of the Foundry operation.

E 9. Selection of the managerial cadres for the key positions of the project for the foundry in question is the most effective guarantee of success in this complex venture.

E 10. According to the legislative decree of August 19, 1969, signed by the President of Syrian Arab Republic Scientific Studies and Research Centre is exempted from all taxes, custom duties etc. Taking this into consideration the IRR will increase by about 5% when the Foundry is exempted from corporate income tax.

F. RECOMMENDATIONS

It is suggested that UNIDO be consulted when the counterpart is evaluating candidates for the key posts.

F 1. It is advisable to investigate with thoroughness all the items for which the project shows high sensitivity. Especially, the local investment costs (construction, infrastructure) may leave appreciable scope for optimization of expenditures.

F 2. The structure of financial resources committed to the project is not yet known. However, it may be predicted that under current financial regulations (credit) in Syria, the project will have no problem in servicing debt. The project will still be fully sustainable given the attempted introduction of self-financing principles. Additionally, the net financial contribution of the training, consulting and laboratory, whilst not critical to the financial health of the project, can be of significance to the net income.

F 3. The Government is advised to appoint the Project National Director from among the candidates, preferably with an engineering background and sufficient experience in industrial management.

It is also recommended to assign to him an adequate executive authority and clearly define - in a formal nomination document - his/her duties, rights and responsibilities. Effective management, adequate incentives, financial accountability are essential in a reformed economic environment.

F 4. It is essential that every activity of the foundry in the future, e.g. laboratory testing, on-the-job training, technical or financial expertise, special finishing of the castings, etc., should be sold at commercial rates to customers. Creation of sustained demand for laboratory services and proper marketing of the project's output (quality!) is important not only from the micro-financial but also from a macro-economic point of view.

F 5. The viability of a foundry depends on technical aspects: high productivity and reduced waste, as well as on economic factors: proper financial accounting, application of economic calculus, expert management.

ANNEX 1

Concept of Pilot Foundry ....

1. Technical Data on Foundry Building ....
2. Characteristics of Foundry Processes ....
3. Melting Section ....
4. Moulding Section ....
5. Core-making Section ....
6. Review of moulding and core-making techniques ....
7. Cleaning/Fettling Section ....
8. Laboratory ....
9. Patterns and Core-boxes ....
10. Raw materials ....
11. Training ....
12. Manpower ....
13. Pricing and Sales ....

Environmental Aspects ....

Safety Aspects ....

ANNEX 2

Financial Evaluation /Tables, Graphs/

ANNEX 1.

CONCEPT OF PILOT DEMONSTRATION FOUNDRY (PDF)

1. Technical Data on Foundry Building

(i) Building lay-out; PDF 500 Appendix No 1/PDF 1500 Appendix No 2
(ii) Overall site: PDF 500 - 35.000; PDF 1500 - 35.000 m2
(iii) Area of the building: PDF 500 - 1.200;PDF 1500 - 3.500 m2
(iv) Storages, social building: PDF 500 - 2.200; PDF 1500 , - 2.700 m2
(v) Foundations - reinforced concrete
(vi) Windows, doors, gates - steel profiles
(vii) Auxiliary systems:
- general exhaust - ventilation system plus individual fans at some working stands
- water supply/sewage system
- compressed air
- electrical and lighting systems
- heating system
- fire alarming system
- telephone communication network.

The foundry building will accommodate the following sections/shops:

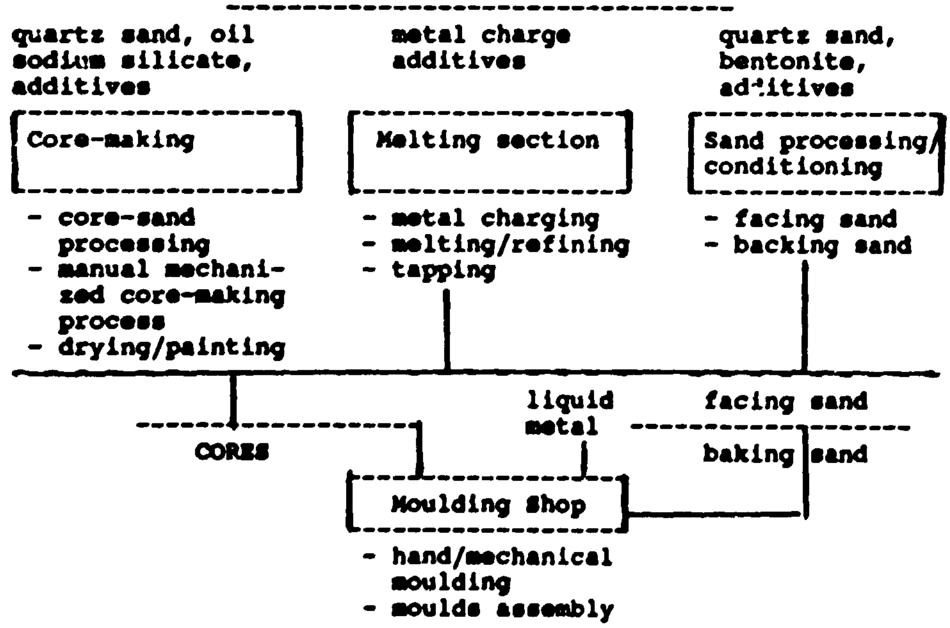
- melting
- sand processing/conditioning station
- mechanized moulding section
- hand moulding section for prototype/pilot production
- cleaning/fettling shop
- heat-treatment.

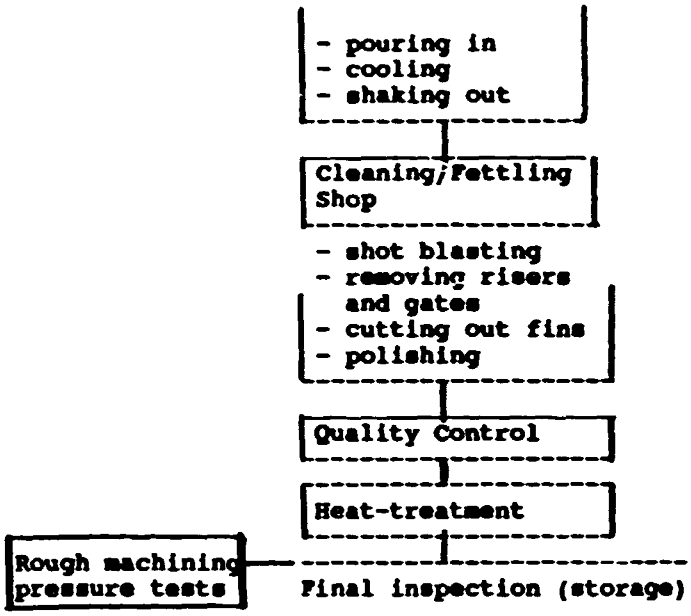
The rough machining section incl. pressure testing stands and auxiliary materials storages will be accommodated separately.

2. Characteristics of Foundry Processes

A "Flow Process Chart" shown below may be used for quick references illustrating operations of the process to be employed.

PILOT FOUNDRY - FLOW PROCESS CHART





3. Melting Section

The section will be equipped with two melting units, namely:

- electric-arc furnace (E.A.F) of loading capacity V = 1.5 t
- induction medium-frequency furnace (I.M.F.F) of loading capacity V= 500 kgs

Due to scarcity of classified and/or sorted scrap in Syria the EAF will be mainly utilized in remelting and refining of various lots of both scrap locally supplied; over 80% of metal scrap used in the process will be an unsorted mix of steel and cast iron.

In order to unify the chemical composition of metal charge for the IMFF the duplex process is envisaged to be employed. The IMFF unit will be operating as a source of high quality cast steel of a strictly controlled chemical composition, based on the return scrap recovered in foundry processes.

The use of two electric melting furnaces i.e. both induction and electric-arc type is commonly considered appropriate in conditions similar to those prevailing in Syria at present.

Such a combination of the melting units is characterized by the following advantages:

(a) maximum utilization of unsorted scrap available from the local market;

(b) provision of high quality refined liquid metal and its further processing in the IMFF; both operations are desired in order to manufacture special grades of cast steel;

(c) flexibility in using various unsorted scrap and comfortable position of the Foundry as to the regular procurement of scrap irrespective of its chemical composition;

(d) appropriate melting facilities for the manufacture of prototype castings and new cast alloys;

(e) capacity sufficient for the provision of liquid steel for the output of about 2.000 tons of castings, if demanded, upon the completion of the project and expansion of other sections of the Foundry.

Operating time and calculated output of the Melting Section

(i) Gross disposable working time:

- 290 working days/year
- 1 shift working system
- 2 days a month used for preventive maintenance of the furnaces
- 12 days a year scheduled for major repair and maintenance services
- total scheduled idle time = 36 days

(ii) Net apparent time:

290 - 36 = 254 days

(iii) IMFF (induction furnace): V = 500 kgs

- 3 melts/shift x 2 shifts = 3 t liquid metal/day
- 254 days x 3 t = 762 t/year

(iv) EAF (electric arc furnace) V = 1.5 t

- 2.5 melts/shift x 2 shifts = 5 melts of total output of 7.5 t/day
- 254 days x 7.5 = 1.905 t/year

(v) Total production of liquid metal of about:

PDF 500 - 1.100 t of cast steel (3 melts/day)
PDF 1500 - 1.900 t of cast steel (5 melts/day)
- 760 of grey cast iron (6 melts/day)

Table No 24

BALANCE OF METAL CHARGE (at full-scale operation)

PDF 500

			tonnes
Sound castings	100%	[54%]	530
Rejected castings	15%	[8%]	80
Feeding system	55%	[30%]	300
Metallurgical losses	5%	[4%]	30
TOTAL liquid metal	175%	[95%]	940
Physical losses	5%	[4%]	50
Total cold metal charge	180%	[100%]	990
Metal yield:	54%		

PDF 1500

tonnes

	Steel castings		Grey iron castings	
Sound castings	100%	1000	100%	500
Rejected castings	15%	150	10%	50
Feeding system	55%	550	20%	100
Metallurgical losses	5%	50	2%	10
Total liquid metal	175%	1750	132%	660
Physical losses	5%	80	3%	20
Total cold metal charge	180%	1830	135%	680

Metal yield: 73%

* The figure calculated for conventional techniques of moulding. In case exothermic risers are used the overall weight of feeding system will accordingly be reduced.

** The percentages of rejected production estimated at 20% for steel castings and 15% for grey iron castings are is justified by the pilot type of the Foundry, quality of the local moulding materials (not of the highest standards) and poor industrial tradition in foundry practice.

4. Moulding Section

Since the majority of foundry output will be of batch (serial) type the provision of moulding machines will be made as to meet the quantitative standards of the Pilot Foundry.

In order to overcome the drawbacks of both the squeeze and joint principles of sand ramming and to achieve uniform density and hardness in all portion of the mould a combination of a squeeze and joint actions will be employed.

A joint action will be used to consolidate the sand on the face of the pattern and be followed by a squeezing action to impart the desired density in the upper portion of the mould.

Mechanically made moulds are required to be produced in moulding flasks of the standard dimensions of 500 x 600 x 175 mm and/or 500 x 600 x 100 mm both relevant to the size of moulding machine table.

Two moulding machines of the type described above and recommended for the Moulding Section are specified in the list of equipment included into this report.

Hand moulding operations will principally be applied for the pilot production of prototype castings and, for any jobbing order, if technologically and qualitatively acceptable.

No specific hand moulding technique is recommended at the moment, as it depends on several factors characterizing the casting that is to be manufactured.

It is, however, envisaged that the following moulding techniques namely: one based on sodium silicate binder, two chemically bonded sands and three shell moulding technique will be employed.

The use of sodium silicate as a binder has considerably increased in recent years. It enables the preparation of mould and cores without any need for drying or baking and in certain cases even without ramming the sand.

Patterns used with these moulding processes may be made of wood or metal. Wooden patterns if painted with synthetic enamel paint are difficult to strip. Such patterns should only be given a coat of shellac or varnish. If paint is essential, a nitro-cellulose base aluminium paint may be used. Greater draft allowance on the patterns may have to be given if the stripping problem persists.

The moulding machines recommended for the Pilot Foundry will be fed with moulding sand by means of overhead conveyers and sand hoppers. Filling out the moulding flasks will be done by the use of lever of the machine, manually operated.

The hand-moulding stands will be supplied with moulding sand transported in portable hoppers by means of overhead crane or battery run platform truck.

After assembly the moulds will be delivered to the pouring in area on the line of roller-conveyers; the hand made moulds will be filled out of liquid metal directly on the floor.

5. Core-making Section

Classified silica sand locally available (Palmyra type) is expected to be used for core-making.

Heavy duty or special castings would require the cores made of chromite or zirconium sands entirely imported from abroad.

There are three basic binders of core sands (ref. table) used in foundry practice and recommended to be introduced namely:

- natural (vegetable) oils
- sodium silicate
- chemical (synthetic) resins.

The CO2 process is considered appropriate for the cores of gate valve bodies due to their shape, volume and mechanical properties all eliminating the use of costly headed stud or double head chaplets.

Natural oil binders are therefore recommended for small and medium-size cores of simple shape like those e.g. of the cover (lid) of gate valve castings.(Ref. table)

Core-sand conditioning will be done alternatively in one of the two mixers depending on the binder used i.e.:

(a) paddle mixer - for sands based on sodium silicate
(b) muller mixer - oil bonded sands.

Transportation, loading and unloading of the oil bonded cores to and from the drying oven will be done by the use of core-racks.

The core-finishing stand established for fire-proof coating of the cores is recommended to be equipped with an exhaust ventilating hood. A mixture of zircon flour (fine fraction of zirconium sand) with water or alcohol would be applied for the core coating.

Cores required for the regular production will be made by means of core-blower of capacity 5-10 liters.

The core-blowing machine is considered indispensable for core making in a production foundry.

6. Review of moulding and coremaking techniques

[Tables: 25, 26, 27, 28]

The method of moulding to be used must be related to the type of castings to be produced and to the skills and equipment available in the foundry. Small castings are usually produced in sand moulds, by hand if the quantities are not large, or on moulding machines for repetition work.

<u>Green sand moulding</u>: this is the most widely used moulding method for small to medium castings in all types of metals. The moulding sand is clay bonded and the moulds remain most ("green"). Throughout all their stages of production and at the pouring operation. Green sand moulding has the following advantages:

- ready availability of the raw materials quartz sands and clay;
- possibility of using recycled moulding sand - as the minor quality deterioration after casting can easily be compensated for;
- production of quality castings due to the high degree of mould strength and gas permeability of the mould.

<u>Dry sand moulding</u>: this is an extension of the green sand technique. Slow rate of production and high skilled labour requirement. Largely replaced by cold set-moulding techniques.

<u>Loam moulding</u>: slow and laborious process requiring much skill, all of the work being done by hand. Has been largely replaced by modern moulding techniques.

Cement moulding: is the forecomer of the cold-setting processes. Cement bonded sand mixes are inexpensive and the sand may be partly reclaimed.

Casting quality is good but mould hardening and rate of production slower than when using newer cold-setting systems. Cement sand moulding is used for heavy casting in steel or cast iron.

CO_2 Process: the carbon dioxide/sodium silicate process for the bonding of moulds is simple. A binder based on a solution of sodium silicate is mixed with silica sand and the flowable mix is easily compacted to form the mould. The CO_2 gassing process has a profound effect on the strength of moulds. Various mould gassing arrangements are used. Highly efficient gassing is obtained where moulds are placed in a chamber from which air is evacuated prior to introducing CO_2. Castings made by this process are dimensionally accurate, have a good surface finish and are less likely to suffer from porosity and blowhole defects. CO_2 process mould may be made on jolt-squeeze moulding machine.

Advantages of CO_2 moulding*

(i) There is considerable saving of labour in making moulds and cores; even heavy and medium weight castings need not be carried to the oven and from there to the pouring area. Manual work is thereby greatly reduced. Costs too are cut as rush orders can be quickly fulfilled and floor space is saved.

(ii) High accuracy and good surface finish on castings are possible. The process can serve as an inexpensive substitute for dry sand moulding where close tolerances are specified

(iii) Withdrawal of pattern is facilitated since the moulds may be hardened before extracting the pattern.

(iv) The likelihood of rejections is less whilst productivity is higher. Mould cracking and deformation are also prevented.

(v) The process can be mechanized and adapted even for mass production.

(vi) Less moulding skill is required than for dry sand moulding

(vii) Reduced machining allowances are required.

(viii) The method is versatile as it can be easily used by small and medium, foundries for light and medium weight castings and for ferrous and non-ferro s foundries alike.

In view of its overwhelming advantages and versatility, the CO_2 process has proved successful for large and diversified applications, such as parts of pumps and compressors, machine tools, wheel castings, railway components, diesel engine parts, reduction gear casting, etc.

* Ref.: BCIRA report published in the "British Foundryman", October 1985 (photo-copy attached).

Cold-set sand moulding: Such sands harden in a predictable manner at room temperature. Binder systems are based on furan, phenol formaldehyde or phenolic urethane resins or sodium silicates and a suitable hardening agent or catalyst- is added during the mixing of the sand. The speed of cold setting is controlled by the amount or strength of hardener that is added to the sand/binder mix. Cold-setting may be extremely rapid as is required for high rates of small mould production, or slow when making large moulds. The moulding lay-out may be very simple and consist of a stationary mixer with moulding boxes and moulds circulating on a roller track around the mixer. Wood patterns are perfectly satisfactory they are of high quality and properly coated. Reproducible accurate casting dimensions are obtained and casting surface quality is generally excellent. The cold-set moulding process is very flexible and is used for producing castings in all metals and alloys weighing from a few kilogrammes up to 200 tonnes. Table 6.7a gives comparative mix sand cost for cold box process.

Shell moulding process: This requires the use of metal patterns. These are heated to about 250oC and then covered (either by damping or blowing using a special machine) with sand which has been previously mixed with 3 to 5% of a heat-curing phenolic resin. After a few minutes a hardened layer of 1 or 2 cm builds up on the pattern; the loose sand behind is tipped away for re-use and the hardened shell is removed when cured by further heating. Two shells are clamped or glued together for pouring. The powdered resin may be simply mixed with the sand but it is more effective to use sand whose grains have been coated with resin. It is advisable to purchase coated sand: although the coating process is not very complicated, it requires careful technical control and is not usually worthwhile for small quantities. Shell moulding requires relatively little skill from the operators although it demands high skills from the pattern makers. The process can produce accurate. smooth. high quality castings in most types of metal. Shell moulds can be stored for long periods without damage and the process can be modified in many ways for high production. Shell moulding is not a cheap method, especially if resin coated sand has to be imported. It is suitable only when relatively highly priced castings are to be made which justify the cost of the resins and the expensive metal patterns.

Other gas hardening moulding processes: In recent years modified systems using gaseous amines to harden phenolic urethane bonded sands and sulphur dioxide to harden furan and phenol formaldehyde resin bonded sands have been introduced. Outputs of mould can be high and accurate castings with a good surface finish are produced from wood and plastic patterns. The techniques are used only for making small castings in mass or small quality production. Machines are available, that produce gas hardened contoured moulds as possible alternatives to normal shell moulds, and whilst the shells are thicker, binder and energy usage is less and high quality castings are made using much lower cost patterns.

Special sand moulding processes: these constitute the V-process and the EPC process.

a) The V-process moulding (Vacuum Sealed Moulding Process) was originated in Japan and the technique of this process involves the use of a vented pattern on a hollow carrier plate or suction box. A thin plastic film with specific physical properties is softened by radiant head and draped over the pattern. The carrier plate is then evacuated, causing the film to conform to the contours of the pattern. A moulding box is placed over the film coated pattern and filled with dry unbonded sand which is consolidated by vibration. The top of the box is similarly covered with a plastic film, air is evacuated through vents in hollow walls or pipes in the box and the sand mould becomes rigid. The pattern is withdrawn after releasing the vacuum applied to the hollow carrier plate. The second half of the mould is made in a similar manner. The moulds are kept under vacuum during subsequent handling and pouring and until the metal has completely solidified.

The technique is used for producing many shapes and sizes of castings in most casting alloys. Its best application is for small quantity production of larger castings - one to several tonnes - of simple configuration. The castings have good dimensional accuracy and surface finish and the process has the capability of producing thin metal sections.

(b) EPC (Evaporative Patter Casting): In this process an expendable pattern of vaporisable material such as polystyrene foam is embedded in the moulding material in a moulding box, generally a one part box, the mould then being immediately ready for pouring without the need to remove the pattern. Molten metal is poured into the "Full Mould", vaporizing the pattern and filling proceeds, and perfectly reproducing the pattern.

Casting quality can be satisfactory and for single or very small batches of castings, pattern and moulding costs are lower than when using corresponding wooden patterns.

Other special moulding and casting processes

Investment casting or lost wax process: this is based on an ancient method of making castings; a one part mould is produced by coating (investing) a wax replica of the final casting with a refractory slurry that sets at room temperature. The wax is then melted or burned out leaving a cavity in the mould of exactly the same shape as the original wax pattern. This casting technique has been established as an accurate one for the manufacture of extremely critical castings and reliable engineering components.

The two main techniques in general use for the production of moulds in the investment casting process are:

(a) the preparation of a "block" or solid mould
(b) the manufacture of a ceramic shell.

The investment casting process is used for a wide range of alloys including nickel-rich materials, the 'super alloys', stainless steels, irons, copper based alloys and light metals. Machining requirements of the castings are minimal. Mechanization of the process is gaining momentum and robot mechanical aids can be used for readily programmed sequences such as shell build-up investment.

Ceramic moulding: Casting quality lies between that obtained by investment casting and sand casting. Ceramic moulded castings have excellent surface finish. There are virtually no alloy limitations. Automatic machines are available for producing ceramic shell moulds at an output of 240 shells an hour and the ceramic moulding process has produced castings from a few grammes up to three tonnes in weight. The process is used for manufacturing among others: food machinery, aluminium parts for electronics, pattern equipment, dies for casting, forging etc.

Die Castings: This technique yields medium to long runs of precise, intricate, smooth surface in a wide range of alloys; the die or mould is invariably of cast iron or steel, although refractory metal dies based on such materials as tungsten and molybdenum are employed when casting high melting point alloys, such as stainless steels. The trend is towards increasingly thinner and more accurate castings with complete automation of the casting process.

(i) Gravity diecastings: The process is often used where capital outlay is limited and where the overall volume of castings does not justify the high initial die cost of the pressure diecasting process, and it may be used for smaller scale production. The moulds are arranged to open and close and be clamped together manually or mechanically, as they are likely to be too hot and heavy for hand operation. Metal is poured manually and after solidification the casting is removed. The maximum weight of gravity die castings is around 15 kg, of copper and aluminium based alloys and grey and SG irons.

(ii) Low pressure diecasting: This can be regarded as and extension of the gravity process but pouring of the metal is more closely controlled and production rates are higher. Low pressure diecasting may compare favourably with high pressure diecasting as regards process capability but has a slower cycle and is therefore better suited to lower quantity requirements. This casting process can be completely automated with precise machine control and weights of castings can range from less than one kg up to 150 kg. The metals employed are usually aluminium alloys (British Standard 1490 of the "LM" series) but is not necessarily limited to aluminium castings.

(iii) High pressure diecasting: This casting process is widely used for large volumes - 5000 minimum of zinc and aluminium castings of intricate shape.

The Centrifugal Casting: The characteristics of centrifugal casting are as follows:

(i) The control of wall thickness is easy.
(ii) As the centrifugal casting force helps to feed the solid-liquid interface, the microstructure across the wall is fine and dense.
(iii) Impurities are confined near the inside surface by centrifugal casting force.
(iv) This method is useful in producing dual metal castings, which consist of two concentric layers bonded together metallurgically.
(v) This method is ideal for efficiently manufacturing the same shape and size of products.

On a large scale, this process is used, among others, for cast iron and SG (spheroidal graphite) iron water-pipes. Centrifugal casting is also used for the manufacturing of mill rolls (adamite rolls, high chromium composite rolls).

7. Cleaning/Fettling Section

Fettling and Repair of Castings

Shake-out of Moulds

After the metal has solidified and cooled in the sand mould, the casting will be knocked out by breaking the mould. The moulds may either be broken manually on the pouring floor itself or will be transferred to a vibratory shake-out grid. In the latter case, the mould is dumped on the shake-out where it is rapidly jarred so that the sand falls through a grate below the floor. The casting and moulding boxes will remain on the grate and are removed from there. The mechanical units consist of a perforated plate or heavy mesh screen fixed to a vibrating frame. The screen is vibrated mechanically, producing a jarring action and causing quick separation of sand from other parts.

Cleaning of Castings

This operation of cutting off the unwanted parts, and cleaning and finishing the casting is known as fettling. The fettling operation may be divided into different stages:

- knocking out of dry sand cores;
- removal of gates and risers;

- removal of fins and unwanted projections at places where the gates and risers have been removed and also elsewhere;
- cleaning and smoothing the surface; and
- repairing castings to fill up blowholes, straightening the bent or deformed castings.

(1) Knocking out of dry sand cores. Dry sand cores will be removed by rapping or knocking with an iron bar.

(2) Removal of gates and risers. The choice of method for removing gates and risers from the castings will depend upon the size and the shape of the casting and the type of metal. The options for such work are:

(i) knocking off or breaking with a hammer, which is particularly suited in case of gre·· iron castings and other brittle metals;

(ii) sawing with a metal cutting saw, which may be a band saw, a circular saw, or a power hacksaw (a metal band saw of the "do-all" type best serves the purpose and is considered ideal for steel, malleable iron, and non-ferrous castings);

(iii) flame cutting with oxyacetylene gas is generally adopted for ferrous metals; (i.e. steel castings)

(iv) using a sprue cutter for shearing of the gates;

(v) employing abrasive cut-off machines, which can work with all metals but are specially designed for hard metals, which are difficult to saw or shear.

(3) Removal of fins and unwanted projections. The operation of removing unwanted metal fins, projections, etc. from the surface of the casting is called snagging. While snagging, care must be exercised to see that a proper casting contour is followed and too much metal is not removed. The methods for snagging include:

(i) using grinders of pedestal, bench, flexible shaft, or swing-frame type;

(ii) chipping with hand or pneumatic tools;

(iii) gouging and flame-cutting;

(iv) removing metal by arc-air equipment; and

(v) filling.

Cleaning and smoothening castings. In as-cast state, casting often may have sand particles adhering to their surfaces in a fused form. When the castings are heat-treated, a scale is also formed on the surface. In order that the casting surface be clean and smooth, the adhering sand particles and the scale will have to be removed. The appropriate method recommended for this purpose is shot blasting being carried out in a specially designed cabinet. The abrasive applied in this case is steel shots. As the shots move from the hub of the impeller towards the periphery, their velocity gets accelerated and they finally leave the impeller at a very high velocity, hitting the casting surface with enormous impact. The cleaning unit recommended will be equipped with two blasting impellers strategically positioned at different places all around the casting. The casting will be mounted on a rotating table.

(5) Repairing the castings. Defects such as blow holes, gas holes, cracks, etc. may often occur in castings. Sometimes the castings get broken, bent, or deformed during shake-out or because of rough handling. Or the casting gets warped during heat treatment or while it cools down in the

mould. Such defective castings cannot be rejected outright for reasons of economy. They should be therefore repaired by suitable means and put to use unless the defects are such that they cannot be remedied.

(i) Metal arc welding. Large-sized cracks, blow holes, and other imperfections can be rectified by metal arc welding. A proper selection of welding electrode is vital. A.C. metal arc welding is most often selected for w welding steel castings. The electrodes used should preferably be coated so that a dense and strong joint is produced.

(ii) Oxy-acetylene gas welding. This method, which is the least expensive and easily portable, is suitable where the sections to be welded are not too heavy and where slower cooling rates are required, for instance, to prevent hardenable steels from getting hardened. Gas welding can easily allow the use of a broad flame, which can pre-heat the area ahead of the section being welded. This is not possible in arc welding. The flame temperature is also lower than that of the arc, so cooling rates are slow. An oxidizing flame is used for welding brasses and bronzes, reducing flame for high carbon and alloy steels, nickel alloys, and other hard-facing materials, and a neutral flame for low carbon steels. By using the proper technique, almost all cast metals and alloys, except magnesium, can be gas welded.

Heat-treatment

Heat-treatment process will be applied to most of the steel castings and partly to ductile iron parts particularly those requiring the improvement of relevant mechanical properties and metallographic structure.

The type of treatment and its parameters will strictly depend on the contents of carbon and components especially alloy components.

Specific process designing will be needed for each group of castings manufactured as prototypes or under jobbing order and R/D activities. Most commonly normalizing, annealing or hardening processes are employed in the production of steel castings.

8. Laboratory

The details of conceptual lay-outs and specification of the equipment are included into this draft report. (Attachments: 2,3)

Financial input and work-plan of laboratory

However the concept of laboratory still needs to be studied in order to clarify the following further questions:

(i) to identify the demand for and, draft the respective programme of R & D works particularly those concerning innovative foundry techniques, process designing, standardization etc.;

(ii) to consult the staff of the existing foundries in the country and also other industries on how and to what extent they would utilize the services offered by the Pilot Laboratory;

(iii) to assess the feasibility of laboratory testing for other potential customers;

(iv) to determine an institutional relation between the PDF Laboratory and other institutions in the country in the context of quality control, standardization, equipment.

(v) to undertake a rough financial analysis of such a laboratory unit i.e. its performance, in view of its expected financial self-reliance.

It is understood that an intermediate preparatory assistance mission to SSRC of a UNIDO consultant, a foundry expert in R & D works would be desired to assist in answering the above questions and to select an appropriate profile of the Pilot Laboratory. The period of 4 weeks assignment is considered sufficient for such a preparatory mission.

Chemical analysis

The P.D.F buildings will be adjacent to the Pilot Laboratory spectrometer.

The distance between the spectrometer and the melting furnace of the P.D.F. will be less than 100 mm. A piped transport system if applied, would reduce the transport time enormously.

An intercom system for communication of the results would further improve the response time. With this method of operation no personnel would have to leave the territory of either of both buildings and thus avoiding problems in the field of control, guarding etc.

A simple method for determination of sulphur and carbon in steel will be installed in the rapid (operational) laboratory. Further a chemical drip method may, as alternative to be used for the qualitative analysis of alloying elements in steel and cast iron.

A portable spectroscope may be considered for laboratory work and field work (in other foundries). This instrument is low cost and after gaining experience it is a very simple instrument that can be used for analysis of all kinds of steel and grey iron.

Other laboratory activities

The laboratory will be also utilized for quality control. The other laboratory activities are the following:

- Metallurgical laboratory; properties to be tested:

  * hardness
  * tensile test
  * magnetic particle tester
  * ultrasonic flaw detector

  A heat treatment furnace may be installed at the pilot laboratory for testing purposes.

- Metallographic laboratory
  The complete range of equipment is installed for the preparation of samples. Metallographic microscope will be installed for analysis of structures.

- Sand laboratory
  A complete sand testing section will be installed in the Pilot Laboratory, not only to support the own production of the foundry but also for testing sand of other foundries and local moulding materials.

- Standardization

- Industrial expertise

- R/D activities.

9. Patterns and core-boxes

The production programme of patterns is shown in the Table No 29. The demand for patterns and core-boxes for the period of 2-3 years will be partly met through sub-contracting the required parts by the Project.

As the pattern designing is considered a particularly essential operation in the foundry process, the remaining patterns needed for the pilot and/or jobbing production will have to be produced under a very strict supervision of process designer (pattern-making expert).

All pattern-making facilities exist in the Foundry Dept. of AL-FRAT Tractor Plant in Aleppo which can be considered as a potential source of supply of patterns and core-boxes during first 2-3 years of PDF operation.

It is therefore suggested that a UNIDO pattern-making expert (instructor) will be assigned to the Project a year before the PDF becomes operational in order to supervise manufacturing the patterns in AL-FRAT Plant. He would also act as a training instructor for a group of pattern-makers recruited for the PDF.

10. Raw Materials

The PDF will be functioning based on the local and imported materials. Quantitatively, the major part of the materials like metal scrap, silica sand, bentonite etc. will be supplied from local resources and/or procured through local dealers.

The annual input of the local supply have been roughly calculated on 850 t and 2.250 respectively for PDF 500 and PDF 1500.

Other basic and auxiliary materials like pig iron, ferro-alloys, refractory bricks/lining, core binders, blasting shot etc. will have to be imported in quantities estimated on 350 t/a for PDF 500 and 880 t/a for PDF 1500.

There are few critical points in the question of material supply:

> firstly, the quality of steel and cast iron scrap locally available in an unsorted state; thus very correct scrap processing procedures will have to be applied and, secondly, the provision of sufficient foreign exchange fund needed to purchase and deliver raw materials from abroad on time.

Comparative figures on raw materials consumption are presented in tables .

Moulding/core materials

There are good possibilities to obtain good quality sands in Syria. The foundries situated in are supplied with natural moulding sands from an open mine being exploited for years and situated near the capital.

In order to maintain the appropriate level of quality the Pilot Foundry will be supplied with the following sands:

> (a) facing sand to be made of fresh components i.e. of local silica sands of defined properties and composition and bentonite,
>
> (b) baking sand will be prepared on the basis of local components i.e. the natural moulding sand ("red" sand) and fire-proof clay.

11. Training

Training of PDF staff and labour is considered to be one of the constrains in smooth operating the foundry during first 2-3 years.

Detailed training programmes for all the professional groups of trainees are expected to be drafted by the UNIDO personnel assigned to the Project, based on the actual manpower requirement.

Scope and details of the programmes will depend on the results of recruitment action, i.e. the interviews with the candidates selected by the counterpart staff for specific posts/jobs.

A comprehensive evaluation of their background, experience, qualification and skills will have to be made. In order to do so, a very close collaboration of the counterpart staff with the UNIDO personnel will have to be maintained to complete successfully the recruitment action and training programmes.

Among different and specific training programmes needed are those for managerial staff, production engineers, process designers, pattern-makers, highly skilled technicians of maintenance service, laboratory assistants and, also the workers involved with scrap processing operations (scrap identification, sorting etc.)

Implementation of the training programmes will have to be undertaken in a pre-operational phase of the project as to prepare a skeleton crew capable to operate the equipment to start the production, and function as training instructors.

Various financial resources will have to be secured in order to achieve a relatively high multi-disciplinary skill of employees.

The training is recommended to be carried out by utilizing the following programmes [tables 8, 9]

(i) UNIDO group study tours (SSRC - PDF staff)

(ii) Individual fellowships (foundry engineers, process designers etc.)

(iii) In-plant training programmes, particularly those under UNIDO auspices for engineers, technicians, quality inspectors

(iv) In-plant group training both local and out of the country to be organized based on governmental bilateral agreements and provided by Syrian industries (eg. Hama Steel Plant, Aleppo Tractor Foundry, Milihouse Co. etc.)

(v) On-the-job training particularly for the workers considered to play the role of production supervisors, foremen or group leaders whose professional qualifications require to be significantly up-graded.

Opportunities of training programmes abroad are suggested to be sought through bilateral contracts, e.g. in Egypt, UK, Italy, India, Holland, Turkey, Poland etc. where a rich base of small scale pilot foundries exist along with R/D foundry centres.

The training requirements are presented in tasks respectively, fo. senior staff and production supervisors/skilled workers.

12. Manpower (Table 30/

The overall manpower requirement will be classified in the following categories:

(i) managerial staff
(ii) laboratory/quality control dept.
(iii) supervisory technical staff
(iv) clerical staff/administration

(v) direct labour
(vi) indirect labour.

The provision of manpower for PDF will be made for three consecutive stages corresponding to: pre-operational activities, the first year and, the second and third years of foundry operation. The graduate increase on employment will allow to economize the cost of manpower and to implement the required training programmes outside the PDF.

In the third year of PDF 500 operation the overall employment will reach the figure of 122 persons, of which the assignment to the a/m categories is expected as follows:

(i)	managerial staff	5
(ii)	lab./quality control depts.	14
(iii)	supervisory tech. staff	7
(iv)	administration	26
(v)	direct labour	50
(vi)	indirect labour	20

The increase on manpower in PDF 1500 by about 23 employees, mainly skilled and unskilled workers is subject to production programme ultimately choosen and optimalization of employment.

13. Pricing and sales (Tables: 19, 20, 21)

The following findings have been obtained from the market study:

(i) The prices of locally manufactured castings are relatively high and not adequate to their poor quality; it particularly refers to grey iron castings manufactured on jobbing orders or in short series;

(ii) the local prices are approximately 40-50% higher as compared with European market prices, in case of cast iron rough castings;

(iii) individually imported machined steel castings (jobbing) may be supplied to customers (eg. refinery, cement, fertilizer plants) against such an extreme high price per one kg as USD 12-20;

(iv) free-market prices of imported castings in Syria are approximately 1.5 to 3 times higher than international prices; thus the market for cast spare parts is indeed a sellers market;

(v) at present, there is no significant local foundry plant (workshop) capable to compete with the expected high quality cast products of PDF.

All the castings to be manufactured by PDF have been grouped into four categories of prices determined a.o. by: shape, number of cores, cast material (grade) used, technology employed, number of castings manufactured by means of one pattern etc. etc.

Consequently the unit prices (of one kg) may vary for:

a) grey iron castings:

from USD 1.12 to USD 3.5 (respectively in SYP 50 and 150)

b) steel castings

from USD 4.5 to 8.5 (in SYP 193 and 365).

The proposed prices are considered moderate taking into account such strong market advantages of PDF as: shorter delivery time, saving in foreign currency, flexibility of production, high quality power by quality certification etc.

The experts team is of the opinion that the future production of castings and laboratory services at PDF are viable because of:

- the present high prices of imported and locally produced castings,
- the castings will be produced at PDF against reasonable production costs,
- at the absence of any R/D foundry centre in Syria there is a very strong demand for technical advisory services, implementation of appropriate technologies, technical expertise, etc.

ENVIRONMENTAL ASPECTS

(i) General

From its nature the foundry industry belongs to the heavy basic industry. Therefore on various positions in a foundry attention should be paid to aspects as:

- air pollution control
- industrial waste disposal
- work environment for foundry workers (noise, dust, heat)

(ii) Air pollution, smoke and fume exhaust from melting furnaces and pouring

In Syria there are no standards or requirements that are valid at present for the whole country.

All equipment will be designed, however, with an emission of dust etc. which is well below the 0.2 g/m3.

The materials to be melted are mainly scrap from the local market. They contain impurities (oil, rust and non-metallic parts). When putting these materials into the melting furnace the impurities will burn away and produce smoke and fume. These fumes are exhausted through natural ventilation from the building into the open air.

The fumes contain very little dangerous elements when charging the furnaces with clean good raw materials.

Using scrap that is not clean will influence the working environment in the foundry in negative way.

(iii) No bake moulding line

The selection of the binding process for the no bake moulding system is primarily based on the availability of raw materials in Syria. The environmental aspects of this choice are also positive in respect to other binding systems. Neither the process itself nor the raw materials and the wasted sand are poisonous.

(iv) Green sand moulding

Various equipment in the green sand moulding line are generating dust. No major dedusting equipment is installed because the investments related are very high.

When working in the area of these dust generating equipment, the operators must wear dust masks.

Furthermore the dust generation can be reduced considerably by spraying a controlled quantity of water on the sand immediately after breaking the moulds.

(v) Exhaust air from the shake-out station

The smoke, fume and dust from the shake-out are exhausted only to improve working conditions in this area. The air is very low polluted with dust. The air is exhausted into open atmosphere via a flue.

(vi) Exhaust air from the shotblasting unit

The exhaust air from the shotblasting unit is fed through a fabric filter system to clean it from fine dust.

Installation of this filter is necessary to avoid that sand and dust are returned to the impellers. This would cause excessive wearing of the impeller wheels.

(vii) Industrial wastes

As in many industries also a foundry produces wastes. The majority of the wastes of the foundry is excess sand from the green sand moulding line. This sand consists for 85% out of silica, the remainder is clay. About 0.15% of carbon hydrogen is in the sand. In Europe this sand would be classified as "low-polluted" (same class as domestic rubbish). It is therefore proposed that transport and disposal of the waste is sub-contracted to a local specialized company.

SAFETY ASPECTS

The most obvious source of danger is from the molten metal. The following precautions are therefore absolutely necessary and it is the responsibility of the management to make sure they are carried out:

a) Operators working adjacent to molten metal are required to wear protective clothing e.g., goggles, gloves, solid boots.

b) All the furnaces, ladles, moulds and floor areas are to be kept dry and clean. Molten metal, especially cast iron, may explode when coming into contact with water.

c) Moulds should be properly clamped and weighted together.

d) It is important that ladles and furnaces are properly constructed and maintained. Linings should be inspected periodically and renewed when necessary.

e) All machines areas to be equipped with interlocked safety guards.

f) Machines and equipment are to have a noise-level below 85 decibels where practical.

g) Ear protectors should be worn by operators working in noisy areas.

ANNEX 2

FINANCIAL EVALUATION

/Tables and Graphs/

TABLES AND GRAPHS (FINANCIAL EVALUATION)

Tables:

1. Summary sheet
2. Total initial investment
3. Total investment during production
4. Total production costs
5. Working capital requirements
6. Sources of finance
   (i) construction
   (ii) production
7. Cashflow tables
   (i) construction
   (ii) production
   (iii) discounting
8. Net income statement
9. Projected balance sheet
   (i) construction
   (ii) production

Graphs:

1. Annual cashflow, operation
2. Cumulated cashflow, operation
3. Sensitivity of the internal rate of return
4. Break even chart for 5th year of production
5. Net profit/total sales ratio: sensitivity of production costs
6. Net profit/total sales ratio: sensitivity of sales prices
7. Net cashflow/total sales ratio: sensitivity of operating costs
8. Net cashflow/total sales ratio: sensitivity of sales prices
9. Total sales and production costs.

ANNEX 2

P D F 500

Damascus Foundry, base case
August, 1991
530 t/y capacity

2 year(s) of construction, 15 years of production
currency conversion rates:
foreign currency 1 unit : 43.0000 units accounting currency
local currency 1 unit : 1.0000 units accounting currency
accounting currency: thousand of Syrian pounds

Total initial investment during construction phase

fixed assets:	218131.50	76.880 % foreign
current assets:	3355.00	96.125 % foreign
total assets:	221486.50	77.172 % foreign

Source of funds during construction phase

equity & grants:	74211.50	92.708 % foreign
foreign loans :	102125.00	
local loans :	45150.00	
total funds :	221486.50	77.172 % foreign

Cashflow from operations

Year:	1	4	8
operating costs:	22865.00	46130.00	70740.00
depreciation :	12070.50	9593.70	8346.00
interest :	16662.50	13769.55	0.00
production costs	51598.00	69493.26	79086.00
thereof foreign	58.38 %	56.33 %	37.32 %
total sales :	56330.00	133000.00	149000.00
gross income :	4732.00	63506.74	69914.00
net income :	4732.00	63506.74	34957.00
cash balance :	11858.14	44258.87	43303.00
net cashflow :	28520.64	84453.97	43303.00

Net Present Value at: 9.00 % : 195869.80
Internal Rate of Return: 21.94 %
Return on equity1: 145.23 %
Return on equity2: 159.53 %

Index of Schedules produced by COMFAR

Total initial investment
Total investment during production
Total production costs
Working Capital requirements
Cashflow Tables
Projected Balance
Net income statement
Source of finance

Total Initial Investment in thousand of Syrian pounds

Year	1992	1993
Fixed investment costs		
Land, site preparation, development	3820.000	0.000
Buildings and civil works	18500.000	19200.000
Auxiliary and service facilities	0.000	0.000
Incorporated fixed assets	3010.000	11180.000
Plant machinery and equipment	0.000	111420.000
Total fixed investment costs	25330.000	141800.000
Pre-production capital expenditures	13830.000	37171.500
Net working capital	0.000	3355.000
Total initial investment costs	39160.000	182326.500
Of it foreign, in %	41.726	84.785

Total Current Investment in thousand of Syrian pounds

Year	1994	1995	1996	1997	1998
Fixed investment costs					
Land, site preparation, development	0.000	0.000	0.000	0.000	0.000
Buildings and civil works	0.000	0.000	0.000	0.000	0.000
Auxiliary and service facilities	0.000	0.000	0.000	0.000	0.000
Incorporated fixed assets	0.000	0.000	0.000	0.000	0.000
Plant, machinery and equipment	0.000	0.000	0.000	0.000	0.000
Total fixed investment costs	0.000	0.000	0.000	0.000	0.000
Preproduction capitals expenditures.	0.000	0.000	0.000	0.000	0.000
Working capital	4944.361	2565.569	2787.000	2416.028	2980.930
Total current investment costs	4944.361	2565.569	2787.000	2416.028	2980.930
Of it foreign, %	79.261	94.34[illegible]	90.987	95.416	42.534

COMFAR

-- COMFAR 2.1 - UNIDO INVESTMENT PROMOTION SERVICES, POLAND ---

Total Production Costs in thousand of Syrian pounds

Year	1994	1995	1996	1997	1998
% of nom. capacity (single product).	0.000	0.000	0.000	0.000	0.000
Raw material 1	7915.000	13115.000	16890.000	20590.000	22950.000
Other raw materials	910.000	1365.000	1995.000	2600.000	3200.000
Utilities	595.000	895.000	1140.000	1370.000	1510.000
Energy	865.000	1300.000	1660.000	1990.000	2200.000
Labour, direct	2700.000	3000.000	3400.000	3400.000	10200.000
Repair, maintenance	1000.000	1500.000	2000.000	2500.000	3000.000
Spares	430.000	430.000	1720.000	2580.000	2580.000
Factory overheads	2500.000	3000.000	3500.000	4000.000	5000.000
Factory costs	16915.000	24605.000	32305.000	39030.000	50640.000
Administrative overheads	5800.000	5800.000	7000.000	7000.000	20000.000
Indir. costs, sales and distribution	150.000	150.000	100.000	100.000	100.000
Direct costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Depreciation	12070.500	12070.500	12070.500	9593.700	9516.301
Financial costs	16662.500	16662.500	16419.490	13769.550	10808.190
Total production costs	51598.000	59238.[illegible]	678[illegible]4.990	69493.250	910[illegible]4.480
Costs per unit (single product)	0.000	0.000	0.000	0.000	0.000
Of it foreign, %	58.381	58.424	57.985	56.327	[illegible]2.954
Of it variable,%	0.000	0.000	0.000	0.000	0.000
Total labour	8000.000	8300.000	99[illegible].000	9900.000	29700.000

Total Production Costs in thousand of Syrian pounds

Year	1999	2000	2001- 8
% of nom. capacity (single product).	0.000	0.000	0.000
Raw material 1	22950.000	22950.000	22950.000
Other raw materials	3200.000	3200.000	3200.000
Utilities	1510.000	1510.000	1510.000
Energy	2200.000	2200.000	2200.000
Labour, direct	10200.000	10200.000	10200.000
Repair, maintenance	3000.000	3000.000	3000.000
Spares	2580.000	2580.000	2580.000
Factory overheads	5000.000	5000.000	5000.000
Factory costs	50640.000	50640.000	50640.000
Administrative overheads	20000.000	20000.000	20000.000
Indir. costs, sales and distribution	100.000	100.000	100.000
Direct costs, sales and distribution	0.000	0.000	0.000
Depreciation	8346.000	8346.000	8346.000
Financial costs	7497.399	3794.417	0.000
Total production costs	86583.400	82880.410	79086.000
Costs per unit (single product)	0.000	0.000	0.000
Of it foreign, %	41.361	39.642	37.320
Of it variable,%	0.000	0.000	0.000
Total labour	29700.000	29700.000	29700.000

Net Working Capital in thousand of Syrian pounds

Year	mdc	coto	1994	1995	1996	1997	1998
Coverage	mdc	coto					
Current assets &							
Accounts receivable	30	12.0	1905.417	2546.250	3283.750	3844.167	5895.000
Inventory and materials	135	2.7	6826.972	9102.806	10838.250	12572.180	13764.110
Energy	1	360.0	2.403	3.611	4.611	5.528	6.111
Spares	180	2.0	215.000	215.000	860.000	1290.000	1290.000
Work in progress	10	36.0	469.861	683.472	897.361	1084.167	1406.667
Finished products	3	120.0	189.292	253.375	327.542	383.583	588.667
Cash in hand	3	120.0	100.000	110.833	132.500	140.833	318.333
Total current assets			9708.943	12915.350	16344.010	19320.460	23268.890
Current liabilities and							
Accounts payable	30	12.0	1409.583	2050.417	2692.083	3252.500	4220.000
Net working capital			8299.360	10864.930	13651.930	16067.960	19048.890
Increase in working capital			4944.360	2565.570	2787.001	2416.026	2980.931
Net working capital, local			1155.389	1300.417	1551.611	1662.361	3375.389
Net working capital, foreign			7143.973	9564.514	12100.320	14405.600	15673.500

Note: mdc = minimum days of coverage ; coto = coefficient of turnover .

COMFAR 2.1 - UNIDO INVESTMENT PROMOTION SERVICES, POLAND

Net Working Capital in thousand of Syrian pounds

Year	mdc	coto	1999-2008
Coverage	mdc	coto	
Current assets &			
Accounts receivable	30	12.0	5895.000
Inventory and materials	135	2.7	13764.110
Energy	1	360.0	6.111
Spares	180	2.0	1290.000
Work in progress	10	36.0	1406.667
Finished products	3	120.0	588.667
Cash in hand	3	120.0	318.333
Total current assets			23268.890
Current liabilities and			
Accounts payable	30	12.0	4220.000
Net working capital			19048.890
Increase in working capital			0.000
Net working capital, local			3375.389
Net working capital, foreign			15673.500

Source of Finance, construction in thousand of Syrian pounds

Year	1992	1993
Equity, ordinary ..	4000.000	1411.500
Equity, preference.	0.000	0.000
Subsidies, grants .	16340.000	52460.000
Loan A, foreign .	0.000	102125.000
Loan B, foreign..	0.000	0.000
Loan C, foreign .	0.000	0.000
Loan A, local....	18820.000	0.000
Loan B, local....	0.000	26330.000
Loan C, local....	0.000	0.000
Total loan	18820.000	128455.000
Current liabilities	0.000	0.000
Bank overdraft	0.000	0.000
Total funds	39160.000	182326.500

Source of Finance, production in thousand of Syrian pounds

Year	1994	1995	1996	1997	1998	1999
Equity, ordinary ..	0.000	0.000	0.000	0.000	0.000	0.000
Equity, preference.	0.000	0.000	0.000	0.000	0.000	0.000
Subsidies, grants .	0.000	0.000	0.000	0.000	0.000	0.000
Loan A, foreign .	0.000	0.000	-15759.370	-17808.090	-20123.140	-22739.150
Loan B, foreign..	0.000	0.000	0.000	0.000	0.000	0.000
Loan C, foreign .	0.000	0.000	0.000	0.000	0.000	0.000
Loan A, local....	0.000	-3240.139	-3483.149	-3744.385	-4025.214	-4327.113
Loan B, local....	0.000	0.000	-4533.095	-4873.077	-5238.558	-5631.449
Loan C, local....	0.000	0.000	0.000	0.000	0.000	0.000
Total loan	0.000	-3240.139	-23775.620	-26425.550	-29386.920	-32697.710
Current liabilities	1409.583	640.933	641.667	560.417	367.500	0.000
Bank overdraft	0.000	0.000	0.000	0.000	0.000	0.000
Total funds	1409.583	-2599.305	-23133.950	-25865.140	-29419.420	-32697.710

Source of Finance, production in thousand of Syrian pounds

Year	2000
Equity, ordinary ..	0.000
Equity, preference.	0.000
Subsidies, grants .	0.000
Loan A, foreign .	-25695.230
Loan B, foreign..	0.000
Loan C, foreign .	0.000
Loan A, local....	0.000
Loan B, local....	-6053.820
Loan C, local....	0.000
Total loan	-31749.050
Current liabilities	0.000
Bank overdraft	0.000
Total funds	-31749.050

Cashflow Tables, construction in thousand of Syrian pounds

Year	1992	1993
Total cash inflow	39160.000	182326.500
Financial resources	39160.000	182326.500
Sales, net of tax	0.000	0.000
Total cash outflow	39160.000	182326.500
Total assets	39160.000	180915.000
Operating costs	0.000	0.000
Cost of finance	0.000	1411.500
Repayment	0.000	0.000
Corporate tax	0.000	0.000
Dividends paid	0.000	0.000
Surplus (deficit)	0.000	0.000
Cumulated cash balance	0.000	0.000
Inflow, local	22820.000	27741.500
Outflow, local	22820.000	27741.500
Surplus (deficit)	0.000	0.000
Inflow, foreign	16340.000	154585.000
Outflow, foreign	16340.000	154585.000
Surplus (deficit)	0.000	0.000
Net cashflow	-39160.000	-180915.000
Cumulated net cashflow	-39160.000	-220075.000

Cashflow tables, production in thousand of Syrian pounds

Year	1994	1995	1996	1997	1998	1999
Total cash inflow . .	57739.580	82640.840	110641.700	133560.400	149967.500	149000.000
Financial resources .	1409.583	640.833	641.667	560.417	967.500	0.000
Sales, net of tax . .	56330.000	82000.000	110000.000	133000.000	149000.000	149000.000
Total cash outflow . .	45881.450	53664.040	83028.770	89301.550	114883.500	142143.400
Total assets	6353.945	3206.403	3428.667	2976.445	3948.431	0.000
Operating costs . . .	22865.000	30555.000	39405.000	46130.000	70740.000	70740.000
Cost of finance . . .	16662.500	16662.500	16419.490	13769.550	10508.190	7497.399
Repayment	0.000	3240.139	23775.620	26425.550	29386.920	32697.710
Corporate tax . . .	0.000	0.000	0.000	0.000	0.000	31208.300
Dividends paid . . .	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit) .	11858.140	28976.800	27612.890	44258.870	35083.970	6856.594
Cumulated cash balance	11858.140	40834.940	68447.830	112706.700	147790.700	154647.300
Inflow, local	57130.420	82264.590	110247.500	133202.100	149770.400	149000.000
Outflow, local	20767.050	25766.000	34508.180	36747.320	61162.930	39887.800
Surplus (deficit) .	36363.360	56498.590	75739.320	96454.760	88607.490	59112.200
Inflow, foreign . . .	609.167	376.250	394.167	358.333	197.083	0.000
Outflow, foreign . . .	25114.390	27898.040	48520.590	52554.230	53720.610	52255.620
Surplus (deficit) .	-24505.220	-27521.790	-48126.430	-52195.900	-53523.530	-52255.620
Net cashflow	28520.640	48879.430	67808.000	84453.980	75279.060	47051.700
Cumulated net cashflow	-191554.400	-142674.900	-74866.940	9587.039	84866.100	131917.800

Cashflow tables, production in thousand of Syrian pounds

Year	2000	2001	2002	2003	2004	2005
Total cash inflow	149000.000	149000.000	149000.000	149000.000	149000.000	149000.000
Financial resources	0.000	0.000	0.000	0.000	0.000	0.000
Sales, net of tax	149000.000	149000.000	149000.000	149000.000	149000.000	149000.000
Total cash outflow	139343.300	105697.000	105697.000	105697.000	105697.000	105697.000
Total assets	0.000	0.000	0.000	0.000	0.000	0.000
Operating costs	70740.000	70740.000	70740.000	70740.000	70740.000	70740.000
Cost of finance	3794.417	0.000	0.000	0.000	0.000	0.000
Repayment	31749.050	0.000	0.000	0.000	0.000	0.000
Corporate tax	33059.790	34957.000	34957.000	34957.000	34957.000	34957.000
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit)	9656.734	43303.000	43303.000	43303.000	43303.000	43303.000
Cumulated cash balance	164304.000	207607.000	250910.000	294213.000	337516.000	380819.000
Inflow, local	149000.000	149000.000	149000.000	149000.000	149000.000	149000.000
Outflow, local	87082.660	82477.000	82477.000	82477.000	82477.000	82477.000
Surplus (deficit)	61912.340	66523.000	66523.000	66523.000	66523.000	66523.000
Inflow, foreign	0.000	0.000	0.000	0.000	0.000	0.000
Outflow, foreign	52255.610	23220.000	23220.000	23220.000	23220.000	23220.000
Surplus (deficit)	-52255.610	-23220.000	-23220.000	-23220.000	-23220.000	-23220.000
Net cashflow	45200.210	43303.000	43303.000	43303.000	43303.000	43303.000
Cumulated net cashflow	177118.000	220421.000	263724.000	307027.000	350330.000	393633.000

Cashflow tables, production in thousand of Syrian pounds

Year	2006	2007	2008
Total cash inflow	149000.000	149000.000	149000.000
Financial resources	0.000	0.000	0.000
Sales, net of tax	149000.000	149000.000	149000.000
Total cash outflow	105697.000	105697.000	105697.000
Total assets	0.000	0.000	0.000
Operating costs	70740.000	70740.000	70740.000
Cost of finance	0.000	0.000	0.000
Repayment	0.000	0.000	0.000
Corporate tax	34957.000	34957.000	34957.000
Dividends paid	0.000	0.000	0.000
Surplus (deficit)	43303.000	43303.000	43303.000
Cumulated cash balance	424122.000	467425.000	510728.000
Inflow, local	149000.000	149000.000	149000.000
Outflow, local	82477.000	82477.000	82477.000
Surplus (deficit)	66523.000	66523.000	66523.000
Inflow, foreign	0.000	0.000	0.000
Outflow, foreign	23220.000	23220.000	23220.000
Surplus (deficit)	-23220.000	-23220.000	-23220.000
Net cashflow	43303.000	43303.000	43303.000
Cumulated net cashflow	436936.000	430239.000	523542.000

Cashflow Discounting:

a) Equity paid versus Net income flow:

Net present value .... 252639.00 at 9.00 %

Internal Rate of Return (IRRE1) .. 145.23 %

b) Net Worth versus Net cash return:

Net present value .... 247926.40 at 9.00 %

Internal Rate of Return (IRRE2) .. 159.53 %

c) Internal Rate of Return on total investment:

Net present value .... 195869.80 at 9.00 %

Internal Rate of Return (IRR) .. 21.94 %

Net Worth = Equity paid plus reserves

Net Income Statement in thousand of Syrian pounds

Year	1994	1995	1996	1997	1998
Total sales, incl. sales tax	56330.000	82000.000	110000.000	133000.000	149000.000
Less: variable costs, incl. sales tax.	0.000	0.000	0.000	0.000	0.000
Variable margin	56330.000	82000.000	110000.000	133000.000	149000.000
As % of total sales	100.000	100.000	100.000	100.000	100.000
Non-variable costs, incl. depreciation	34935.500	42625.500	51475.500	55723.700	80256.300
Operational margin	21394.500	39374.500	58524.500	77276.300	6874[illegible].700
As % of total sales	37.981	48.018	53.204	58.102	46.[illegible]37
Cost of finance	16662.500	16662.500	16419.490	13769.550	10808.190
Gross profit	4732.000	22712.000	42105.010	63506.740	57935.510
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	4732.000	22712.000	42105.010	63506.740	57935.510
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	4732.000	22712.000	42105.010	63506.740	57935.510
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	4732.000	22712.000	42105.010	63506.740	57935.510
Accumulated undistributed profit	4732.000	27444.000	69549.010	133055.800	190991.300
Gross profit, % of total sales	8.400	27.698	38.277	47.749	38.883
Net profit, % of total sales	8.400	27.698	38.277	47.749	38.833
ROE, Net profit, % of equity	87.443	419.699	778.065	1173.552	1070.630
ROI, Net profit+interest, % of invest.	9.508	17.301	25.404	33.196	29.157

Net Income Statement in thousand of Syrian pounds

Year	1999	2000	2001	2002	2003
Total sales, incl. sales tax	149000.000	149000.000	149000.000	149000.000	149000.000
Less: variable costs, incl. sales tax.	0.000	0.000	0.000	0.000	0.000
Variable margin	149000.000	149000.000	149000.000	149000.000	149000.000
As % of total sales	100.000	100.000	100.000	100.000	100.000
Non-variable costs, incl. depreciation	79086.000	79086.000	79086.000	79086.000	79086.000
Operational margin	69914.000	69914.000	69914.000	69914.000	69914.000
As % of total sales	46.922	46.922	46.922	46.922	46.922
Cost of finance	7497.399	3794.417	0.000	0.000	0.000
Gross profit	62416.600	66119.590	69914.000	69914.000	69914.000
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	62416.600	66119.590	69914.000	69914.000	69914.000
Tax	31208.300	33059.790	34957.000	34957.000	34957.000
Net profit	31208.300	33059.790	34957.000	34957.000	34957.000
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	31208.300	33059.790	34957.000	34957.000	34957.000
Accumulated undistributed profit	222199.500	255259.300	290216.300	325173.300	360130.300
Gross profit, % of total sales	41.890	44.376	46.922	46.922	46.922
Net profit, % of total sales	20.945	22.188	23.461	23.461	23.461
ROE, Net profit, % of equity	576.703	610.917	645.976	645.976	645.976
ROI, Net profit+interest, % of invest.	16.417	15.631	14.827	14.827	14.827

Net Income Statement in thousand of Syrian pounds

Year	2004	2005	2006	2007	2008
Total sales, incl. sales tax	149000.000	149000.000	149000.000	149000.000	149000.000
Less: variable costs, incl. sales tax.	0.000	0.000	0.000	0.000	0.000
Variable margin	149000.000	149000.000	149000.000	149000.000	149000.000
As % of total sales	100.000	100.000	100.000	100.000	100.000
Non-variable costs, incl. depreciation	79086.000	79086.000	79086.000	79086.000	79086.000
Operational margin	69914.000	69914.000	69914.000	69914.000	69914.000
As % of total sales	46.922	46.922	46.922	46.922	46.922
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	69914.000	69914.000	69914.000	69914.000	69914.000
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	69914.000	69914.000	69914.000	69914.000	69914.000
Tax	34957.000	34957.000	34957.000	34957.000	34957.000
Net profit	34957.000	34957.000	34957.000	34957.000	34957.000
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	34957.000	34957.000	34957.000	34957.000	34957.000
Accumulated undistributed profit	395087.300	430044.300	465001.300	499958.300	534915.400
Gross profit, % of total sales	46.922	46.922	46.922	46.922	46.922
Net profit, % of total sales	23.461	23.461	23.461	23.461	23.461
ROE, Net profit, % of equity	645.976	645.976	645.976	645.976	645.976
ROI, Net profit+interest, % of invest.	14.827	14.827	14.827	14.827	14.827

Projected Balance Sheets, construction in thousand of Syrian pounds

Year	1992	1993
Total assets	39160.000	221486.500
Fixed assets, net of depreciation	0.000	39160.000
Construction in progress	39160.000	178971.500
Current assets	0.000	3355.000
Cash, bank	0.000	0.000
Cash surplus, finance available	0.000	0.000
Loss carried forward	0.000	0.000
Loss	0.000	0.000
Total liabilities	39160.000	221486.500
Equity capital	20340.000	74211.500
Reserves, retained profit	0.000	0.000
Profit	0.000	0.000
Long and medium term debt	18820.000	147275.000
Current liabilities	0.000	0.000
Bank overdraft, finance required	0.000	0.000
Total debt	18820.000	147275.000
Equity, % of liabilities	51.941	33.506

Projected Balance Sheets, Production in thousand of Syrian pounds

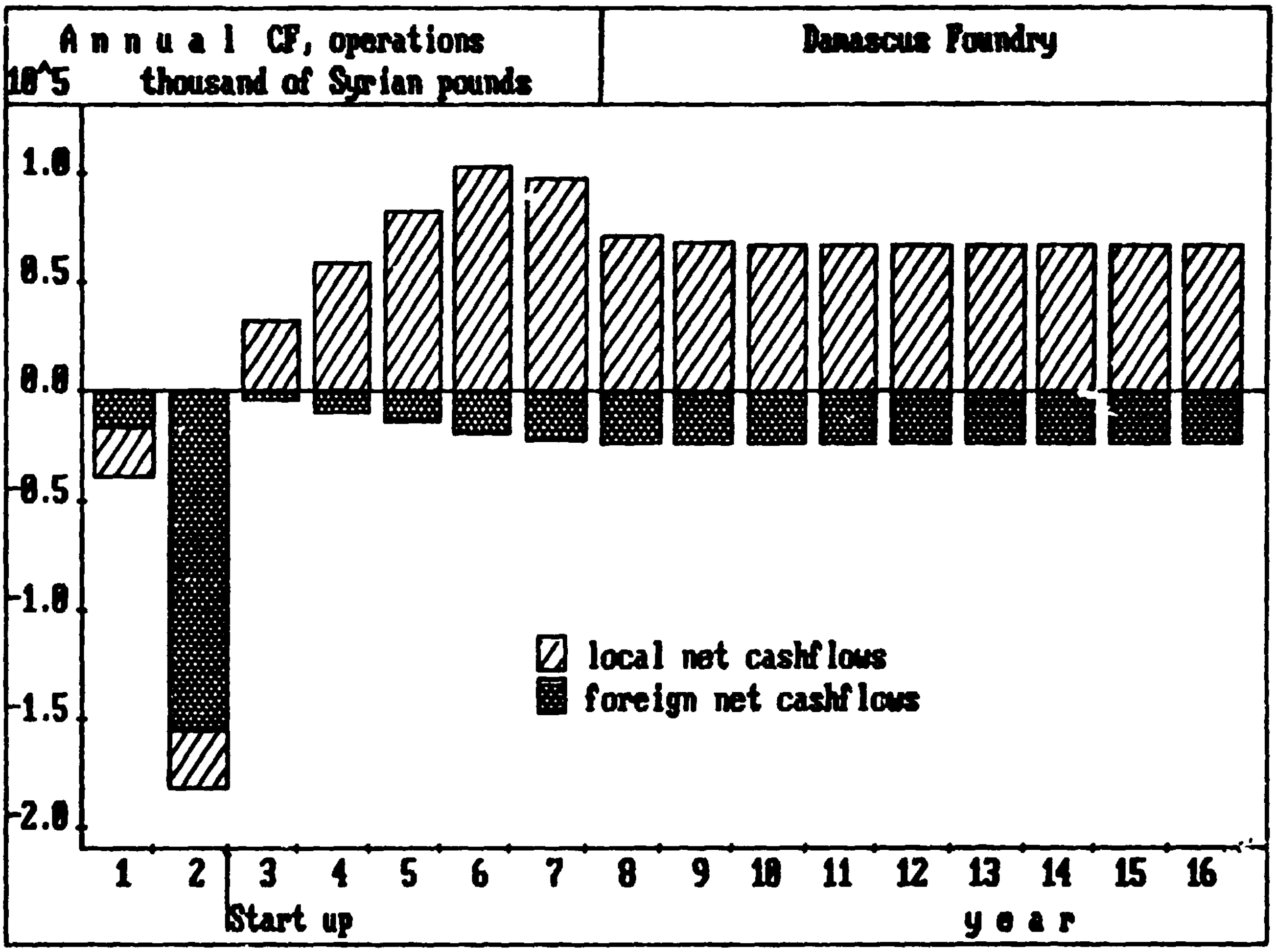
Year	1994	1995	1996	1997	1998
Total assets	227628.100	247740.800	266711.800	304353.400	333869.500
Fixed assets, net of depreciation	206061.000	193990.500	181920.000	172326.300	162810.000
Construction in progress	0.000	0.000	0.000	0.000	0.000
Current assets	9608.945	12804.510	16211.510	19179.630	22950.560
Cash, bank	100.000	110.833	132.500	140.833	318.333
Cash surplus, finance available	11858.140	40834.940	68447.830	112706.700	147790.600
Loss carried forward	0.000	0.000	0.000	0.000	0.000
Loss	0.000	0.000	0.000	0.000	0.000
Total liabilities	227628.100	247740.800	266711.800	304353.400	333869.500
Equity capital	74211.500	74211.500	74211.500	74211.500	74211.500
Reserves, retained profit	0.000	4732.000	27444.000	69549.010	133055.800
Profit	4732.000	22712.000	42105.010	63506.740	57935.510
Long and medium term debt	147275.000	144034.900	120259.200	93833.690	64446.770
Current liabilities	1409.583	2050.417	2692.083	3252.500	4220.000
Bank overdraft, finance required.	0.000	0.000	0.000	0.000	0.000
Total debt	148684.600	146085.300	122951.300	97086.190	68666.770
Equity, % of liabilities	32.602	29.955	27.825	24.383	22.229

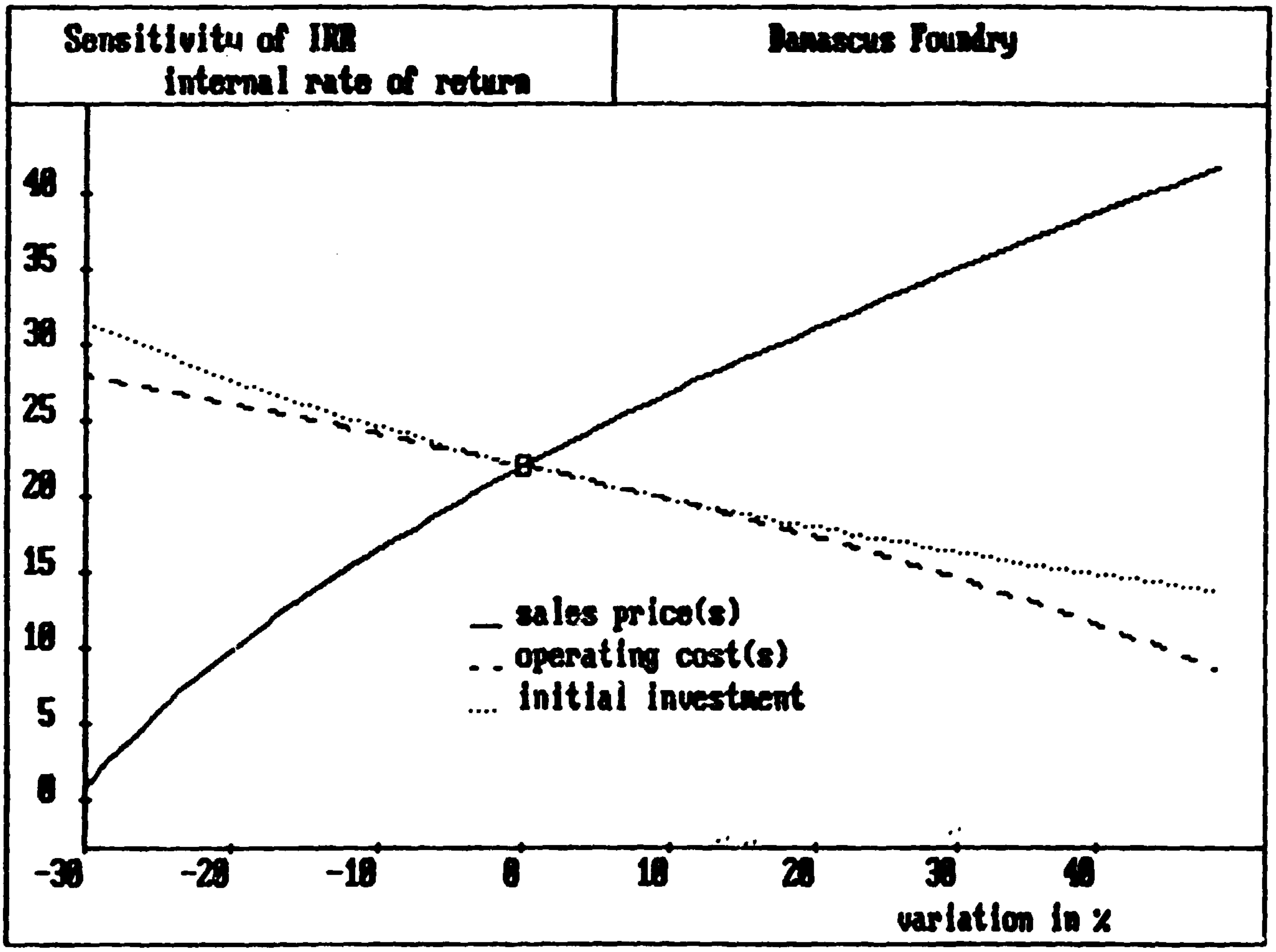
Projected Balance Sheets, Production in thousand of Syrian pounds

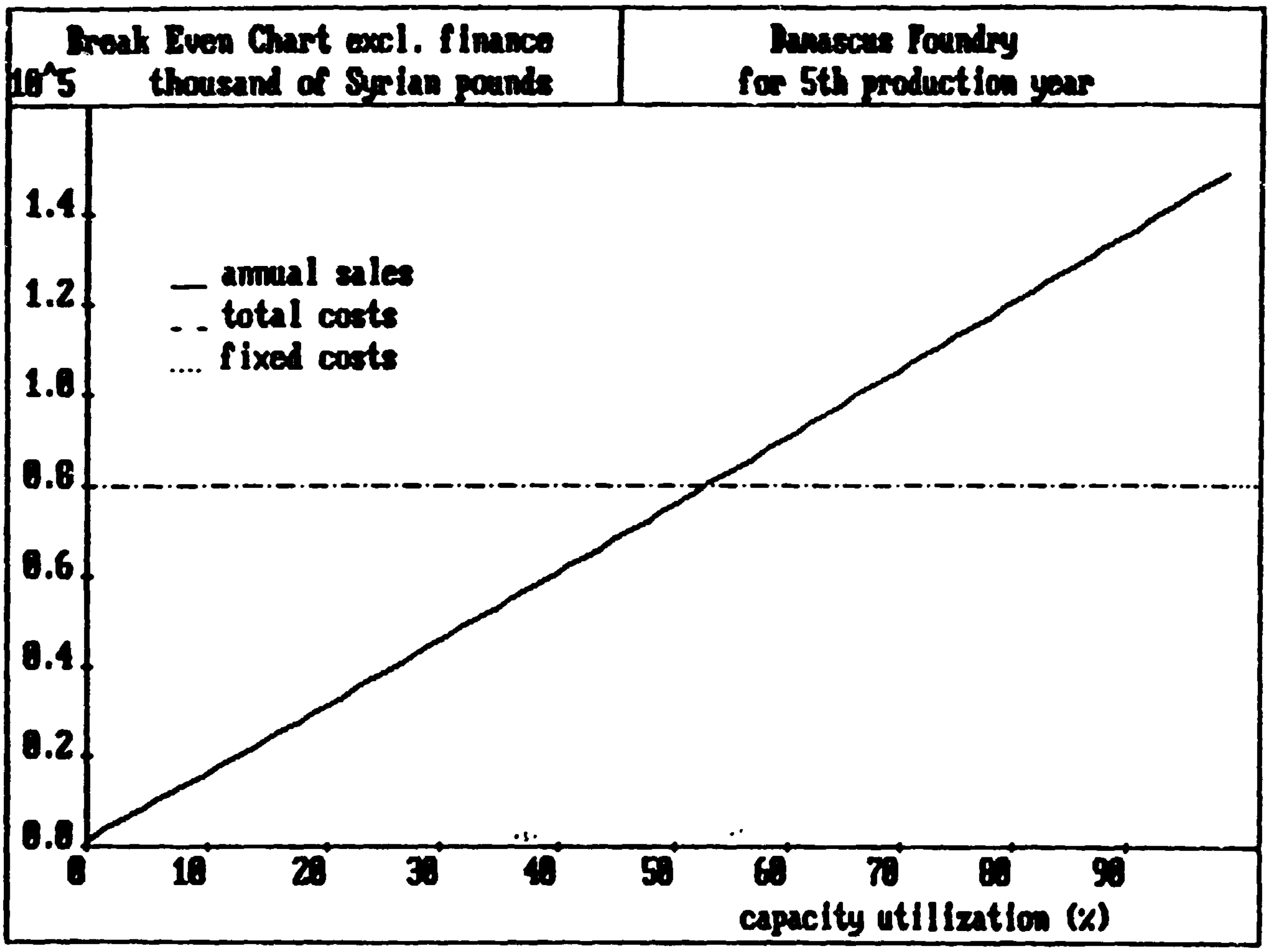
Year	1999	2000	2001	2002	2003
Total assets	332380.100	333690.800	368647.800	403604.800	438561.800
Fixed assets, net of depreciation	154464.000	146118.000	137772.000	129426.000	121080.000
Construction in progress	0.000	0.000	0.000	0.000	0.000
Current assets	22950.560	22950.560	22950.560	22950.560	22950.560
Cash, bank	318.333	318.333	318.333	318.333	318.333
Cash surplus, finance available	154647.200	164304.000	207607.000	250910.000	294212.900
Loss carried forward	0.000	0.000	0.000	0.000	0.000
Loss	0.000	0.000	0.000	0.000	0.000
Total liabilities	332380.100	333690.800	368647.800	403604.800	438561.800
Equity capital	74211.500	74211.500	74211.500	74211.500	74211.500
Reserves, retained profit	190991.300	222199.500	255259.300	290216.300	325173.300
Profit	31208.300	33059.790	34957.000	34957.000	34957.000
Long and medium term debt	31749.060	0.004	0.004	0.004	0.004
Current liabilities	4220.000	4220.000	4220.000	4220.000	4220.000
Bank overdraft, finance required.	0.000	0.000	0.000	0.000	0.000
Total debt	35969.060	4220.004	4220.004	4220.004	4220.004

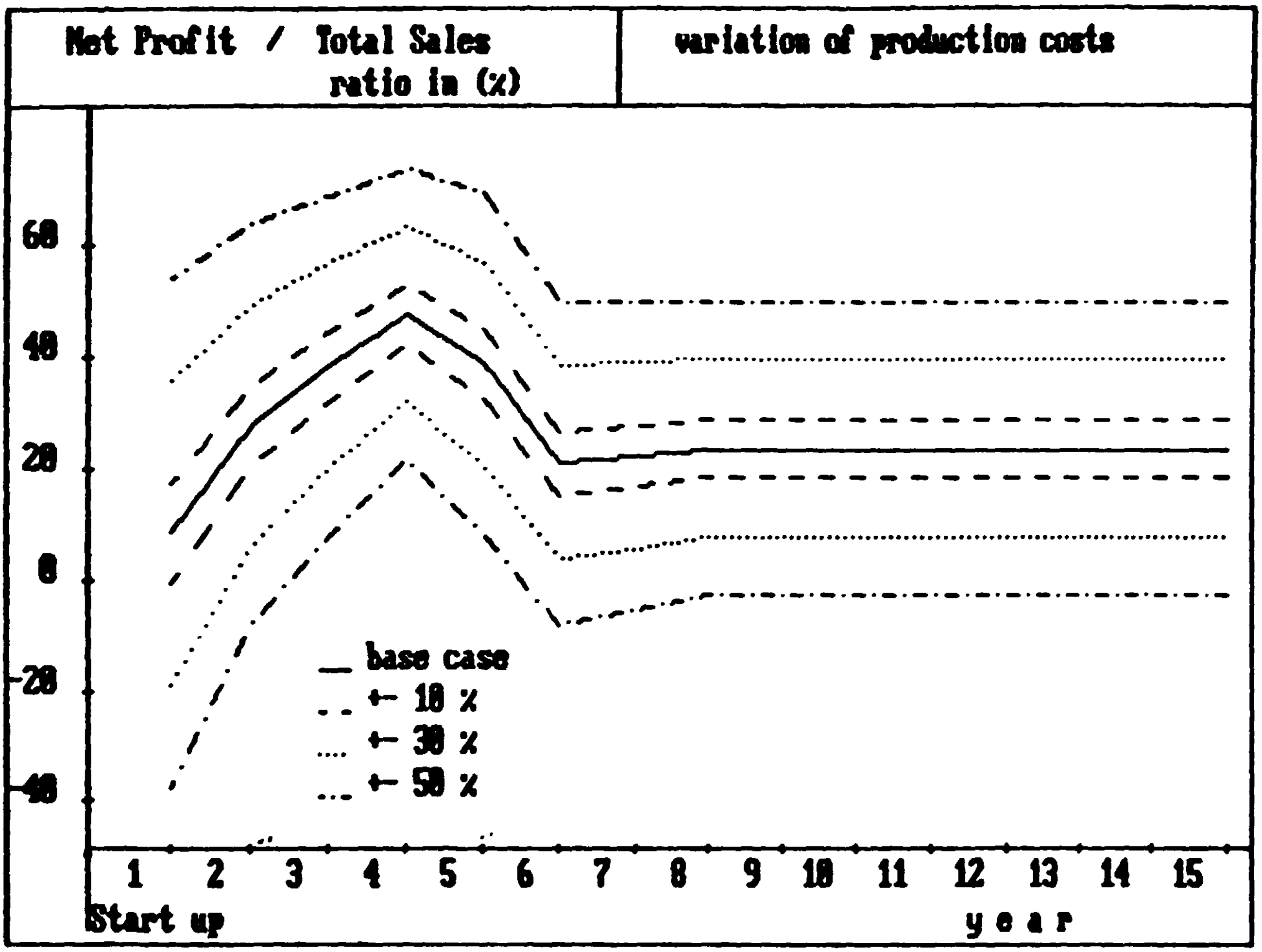
Projected Balance Sheets, Production in thousand of Syrian pounds

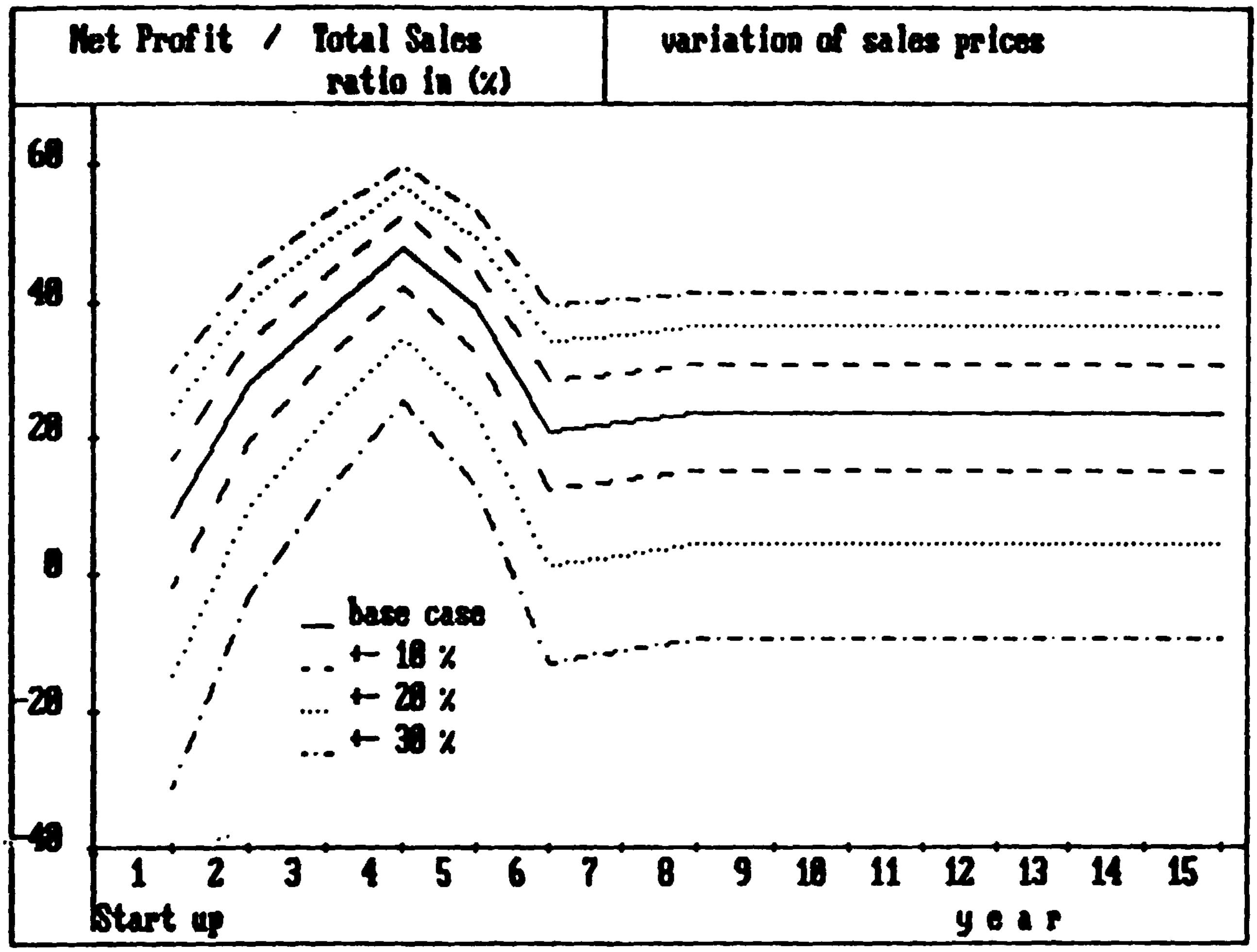
Year	2004	2005	2006	2007	2008
Total assets	473518.800	508475.800	543432.900	578389.900	613346.900
Fixed assets, net of depreciation	112734.000	104388.000	96042.000	87696.000	79350.000
Construction in progress	0.000	0.000	0.000	0.000	0.000
Current assets	22950.560	22950.560	22950.560	22950.560	22950.560
Cash, bank	318.333	318.333	318.333	318.333	318.333
Cash surplus, finance available	337515.900	380818.900	424122.000	467425.000	510728.000
Loss carried forward	0.000	0.000	0.000	0.000	0.000
Loss	0.000	0.000	0.000	0.000	0.000
Total liabilities	473518.800	508475.800	543432.900	578389.900	613346.900
Equity capital	74211.500	74211.500	74211.500	74211.500	74211.500
Reserves, retained profit	360130.300	395087.300	430044.300	465001.300	499958.300
Profit	34957.000	34957.000	34957.000	34957.000	34957.000
Long and medium term debt	0.004	0.004	0.004	0.004	0.004
Current liabilities	4220.000	4220.000	4220.000	4220.000	4220.000
Bank overdraft, finance required.	0.000	0.000	0.000	0.000	0.000
Total debt	4220.004	4220.004	4220.004	4220.004	4220.004
Equity, % of liabilities	15.672	14.595	13.656	12.831	12.099

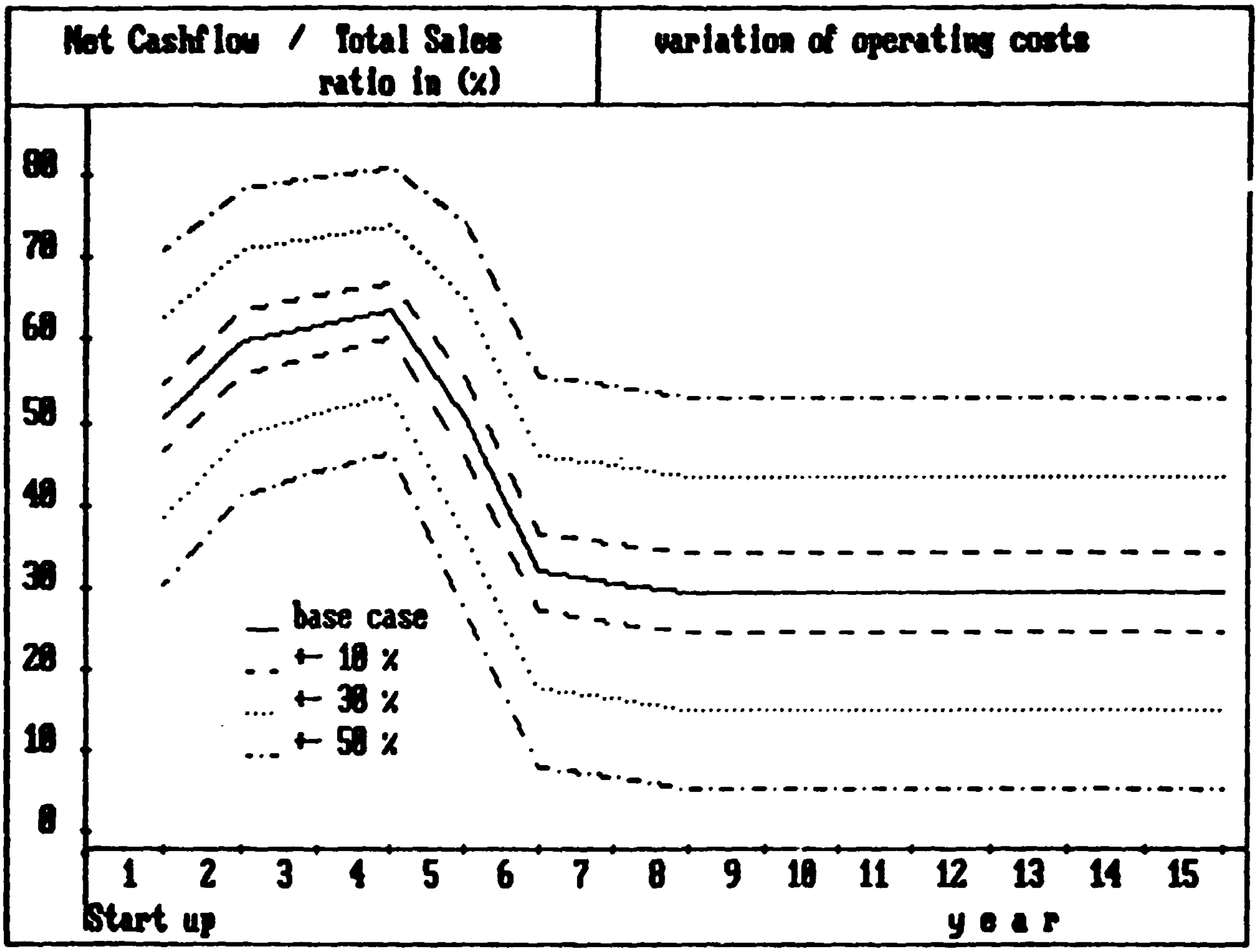

Annual CF, operations
10^5 thousand of Syrian pounds
Damascus Foundry
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
local net cashflows
foreign net cashflows
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Start up
year

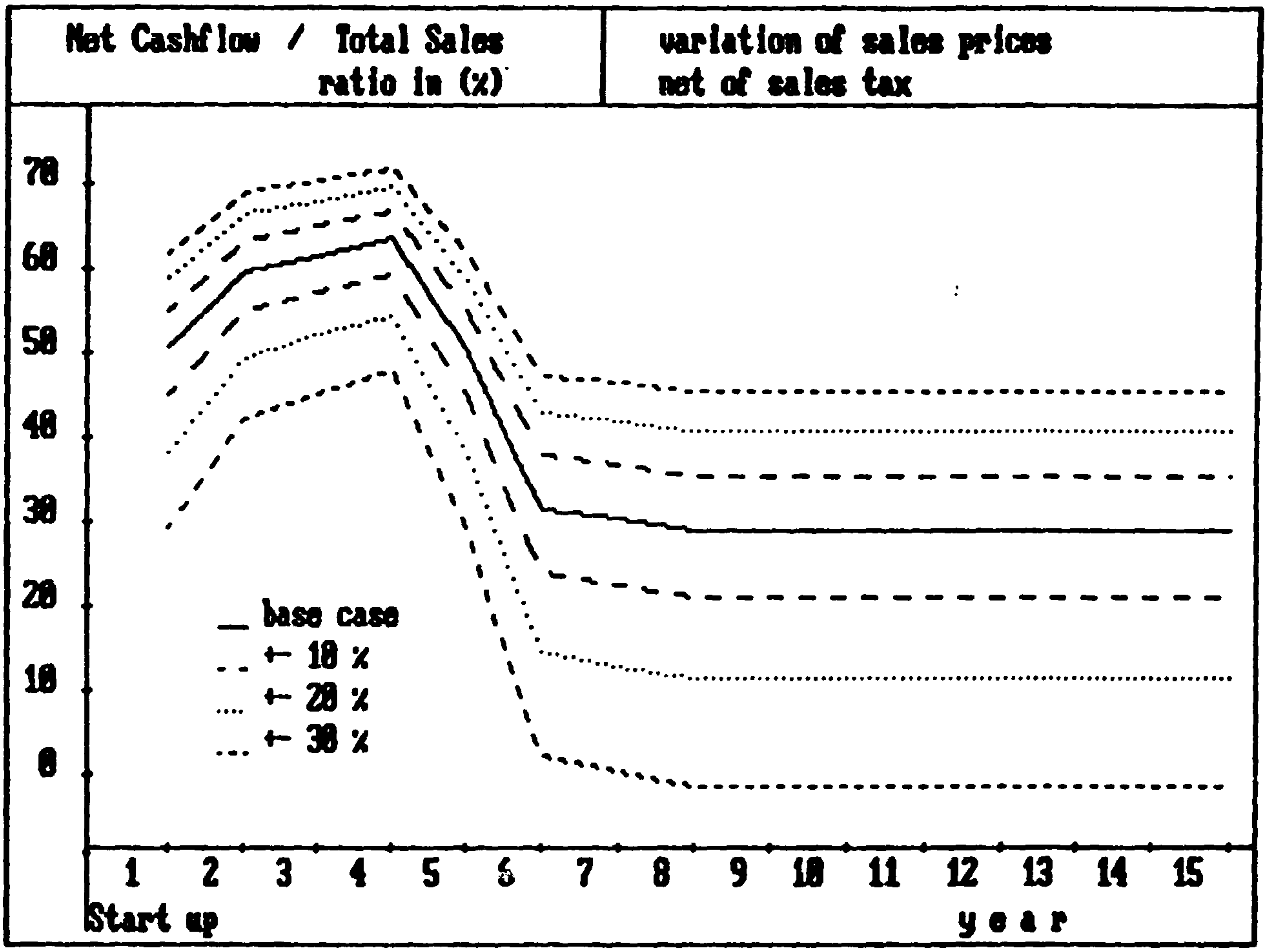

Sensitivity of IRR
internal rate of return
Damascus Foundry
40
35
30
25
20
15
10
5
0
-30
-20
-10
0
10
20
30
40
variation in %
__ sales price(s)
_ _ operating cost(s)
.... initial investment


Break Even Chart excl. finance
10^5 thousand of Syrian pounds
Damascus Foundry
for 5th production year
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
__ annual sales
- - total costs
.... fixed costs
0
10
20
30
40
50
60
70
80
90
capacity utilization (%)

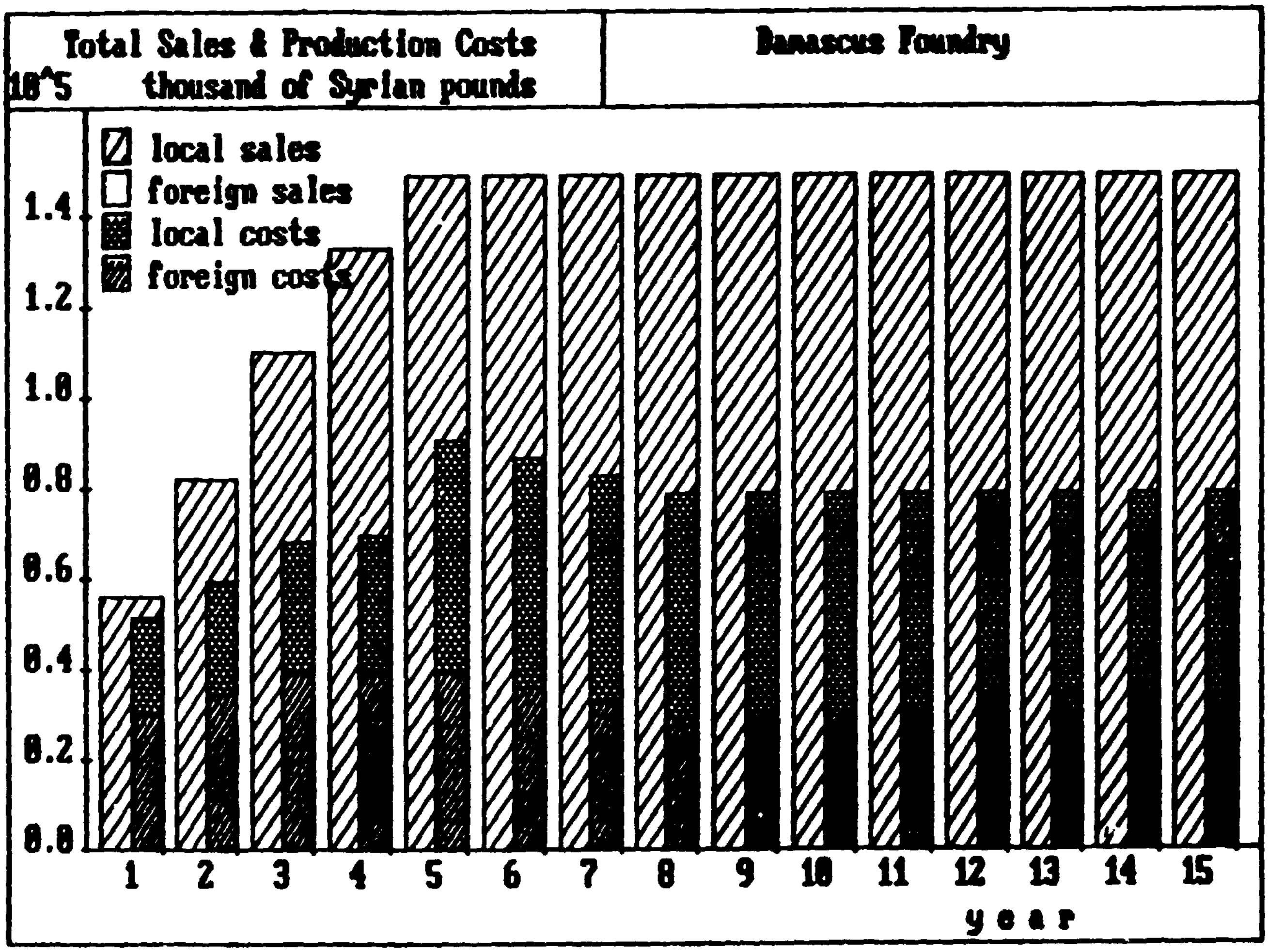

Net Profit / Total Sales ratio in (%)
variation of production costs
60
40
20
0
-20
-40
base case
+- 10 %
+- 30 %
+- 50 %
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Start up
year


Net Profit / Total Sales ratio in (%)
variation of sales prices
60
40
20
0
-20
-40
base case
+ 10 %
+ 20 %
+ 30 %
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Start up
year


Net Cashflow / Total Sales ratio in (%)
variation of operating costs
80
70
60
50
40
30
20
10
0
base case
+- 10 %
+- 30 %
+- 50 %
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Start up
year


Net Cashflow / Total Sales
ratio in (%)
variation of sales prices
net of sales tax
70
60
50
40
30
20
10
0
base case
+- 10 %
+- 20 %
+- 30 %
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Start up
year

COMFAR 2.1 UNIDO



ANNEX 2

P D F 1500

Damascus Foundry, base case
August, 1991
1500 t/y capacity

2 year(s) of construction, 15 years of production
currency conversion rates:
foreign currency 1 unit : 43.0000 units accounting currency
local currency 1 unit : 1.0000 units accounting currency
accounting currency: thousand of Syrian pounds

Total initial investment during construction phase

fixed assets:	287592.50	74.160 % foreign
current assets:	4500.00	95.556 % foreign
total assets:	292092.50	74.490 % foreign

Source of funds during construction phase

equity & grants:	37312.50	38.[illegible] % foreign
foreign loans :	190130.00	
local loans :	64600.00	
total funds :	292092.50	74.490 % foreign

Cashflow from operations

Year:	1	4	7
operating costs:	30710.00	66235.00	105953.00
depreciation :	16608.80	14613.60	12633.60
interest :	23068.40	19068.17	5259.36
production costs	70387.20	99916.77	123846.00
thereof foreign	61.45 %	58.49 %	45.30 %
total sales :	104000.00	256000.00	329000.00
gross income :	33612.80	156083.20	205154.00
net income :	33612.80	156083.20	102577.00
cash balance :	42597.32	129088.00	70950.59
net cashflow :	65665.72	184910.00	120470.00

Net Present Value at: 9.00 % : 668565.20
Internal Rate of Return: 36.01 %
Return on equity1: 192.33 %
Return on equity2: 192.67 %

Index of Schedules produced by COMFAR

Total initial investment	Cashflow Tables
Total investment during production	Projected Balance
Total production costs	Net income statement
Working Capital requirements	Source of finance

Total Initial Investment in thousand of Syrian pounds

Year	1992	1993
Fixed investment costs		
Land, site preparation, development	4400.000	0.000
Buildings and civil works	28600.000	29400.000
Auxiliary and service facilities	0.000	0.000
Incorporated fixed assets	5160.000	17200.000
Plant machinery and equipment	0.000	144880.000
Total fixed investment costs	38160.000	191480.000
Pre-production capital expenditures	14905.000	43047.500
Net working capital	0.000	4500.000
Total initial investment costs	53065.000	239027.500
Of it foreign, in %	36.370	52.542

Total Current Investment in thousand of Syrian pounds

Year	1994	1995	1996	1997	1998
Fixed investment costs					
Land, site preparation, development	0.000	0.000	0.000	0.000	0.000
Buildings and civil works	0.000	0.000	0.000	0.000	0.000
Auxiliary and service facilities	0.000	0.000	0.000	0.000	0.000
Incorporated fixed assets	0.000	0.000	0.000	0.000	0.000
Plant, machinery and equipment	0.000	24080.000	0.000	0.000	0.000
Total fixed investment costs	0.000	24080.000	0.000	0.000	0.000
Preproduction capitals expenditures	0.000	0.000	0.000	0.000	0.000
Working capital	7624.278	1853.068	4797.530	4855.000	7355.205
Total current investment costs	7624.278	25933.070	4797.530	4855.000	[illegible]
Of it foreign, %	84.[illegible]	99.521	91.298	[illegible]	[illegible]

Total Production Costs in thousand of Syrian pounds

Year	1994	1995	1996	1997	1998
% of nom. capacity (single product).	0.000	0.000	0.000	0.000	0.000
Raw material 1	13450.000	17190.000	26640.000	36350.000	48510.000
Other raw materials	930.000	1445.000	2075.000	2605.000	3563.000
Utilities	720.000	950.000	1500.000	2100.000	2700.000
Energy	1700.000	2200.000	2900.000	3800.000	4700.000
Labour, direct	3400.000	3400.000	4200.000	4500.000	14700.000
Repair, maintenance	1000.000	1500.000	2000.000	2500.000	3000.000
Spares	430.000	430.000	1720.000	2580.000	2580.000
Factory overheads	3000.000	3500.000	4000.000	4500.000	5500.000
Factory costs	24660.000	30615.000	45035.000	58935.000	85253.000
Administrative overheads	5900.000	5900.000	7200.000	7200.000	20[illegible]00.000
Indir. costs, sales and distribution	150.000	150.000	100.000	100.000	100.000
Direct costs, sales and distribution	0.000	0.000	0.000	0.000	0.000
Depreciation	16603.800	16603.800	13053.600	14613.600	14506.100
Financial costs	23065.400	23058.400	227[illegible]	19058.170	14767.210
Total production costs	70027.200	76342.200	[illegible]	99916.770	135426.300
Costs per unit (single product)	0.000	0.000	0.000	0.000	0.000
Of it foreign, %	61.451	63.832	60.233	53.490	43.071
Of it variable,%	0.000	0.000	0.000	0.000	0.000
Total labour	9500.000	3800.000	10900.000	11200.000	34800.000

Total Production Costs in thousand of Syrian pounds

Year	1999	2000	2001- 8
% of nom. capacity (single product).	0.000	0.000	0.000
Raw material 1	48510.000	48510.000	48510.000
Other raw materials	3563.000	3563.000	3563.000
Utilities	2700.000	2700.000	2700.000
Energy	4700.000	4700.000	4700.000
Labour, direct	14700.000	14700.000	14700.000
Repair, maintenance	3000.000	3000.000	3000.000
Spares	2550.000	2530.000	2580.000
Factory overheads	5500.000	5500.000	5500.000
Factory costs	85253.000	85253.000	85253.000
Administrative overheads	20600.000	20600.000	20600.000
Indir. costs, sales and distribution	100.000	100.000	100.000
Direct costs, sales and distribution	0.000	0.000	0.000
Depreciation	12633.600	12633.600	12633.600
Financial costs	10383.900	5259.356	0.000
Total production costs	128970.500	123846.[illegible]	118586.600
Costs per unit (single product)	0.000	0.000	0.000
Of it foreign, %	46.650	45.[illegible]	43.447
Of it variable,%	0.000	0.000	0.000
Total labour	34800.000	34800.000	34800.000

Net Working Capital in thousand of Syrian pounds

Year	mdc	coto	1994	1995	1996	1997	1998
Coverage	mdc	coto					
Current assets &							
Accounts receivable	30	12.0	2559.167	3055.417	4361.250	5519.583	8829.416
Inventory and materials	131	2.7	10349.390	11973.390	15467.220	19375.950	24371.780
Energy	1	360.0	4.722	6.111	8.056	10.556	13.056
Spares	180	2.0	215.000	215.000	860.000	1290.000	1290.000
Work in progress	10	36.0	685.000	850.417	1250.972	1637.083	2368.139
Finished products	3	120.0	254.567	304.292	435.292	551.125	882.108
Cash in hand	3	120.0	110.333	119.167	145.000	155.333	365.000
Total current assets			14179.230	16528.600	22527.793	28541.130	38119.500
Current liabilities and							
Accounts payable	30	12.0	2055.000	2551.250	3752.917	4911.250	7104.417
Net working capital			12124.280	13977.350	18774.393	23627.380	31015.080
Increase in working capital			7624.278	1853.070	4797.526	4855.006	7385.203
Net working capital, local			1369.500	1495.611	[illegible]	2155.356	4238.622
Net working capital, foreign			10754.780	12483.730	[illegible]	21474.320	26776.460

Note: mdc = minimum days of coverage ; coto = coefficient of turnover .

COMFAR 2.1 - UNIDO INVESTMENT PROMOTION SERVICES, POLAND

Net Working Capital in thousand of Syrian pounds

Year	mdc	coto	1999-2008
Coverage	mdc	coto	
Current assets &			
Accounts receivable	30	12.0	8829.416
Inventory and materials	131	2.7	24371.780
Energy	1	360.0	13.056
Spares	180	2.0	1290.000
Work in progress	10	36.0	2368.139
Finished products	3	120.0	882.108
Cash in hand	3	120.0	365.000
Total current assets			38119.500
Current liabilities and			
Accounts payable	30	12.0	7104.417
Net working capital			31015.080
Increase in working capital			0.000
Net working capital, local			4238.622
Net working capital, foreign			26776.460

Source of Finance, construction in thousand of Syrian pounds

Year	1992	1993
Equity, ordinary ..	8000.000	1912.500
Equity, preference.	0.000	0.000
Subsidies, grants .	19565.000	57835.000
Loan A, foreign .	0.000	140180.000
Loan B, foreign..	0.000	0.000
Loan C, foreign .	0.000	0.000
Loan A, local....	25500.000	0.000
Loan B, local....	0.000	39100.000
Loan C, local....	0.000	0.000
Total loan	25500.000	179280.000
Current liabilities	0.000	0.000
Bank overdraft	0.000	0.000
Total funds	53065.000	239027.500

Source of Finance, production in thousand of Syrian pounds

Year	1994	1995	1996	1997	1998	1999
Equity, ordinary ..	0.000	0.000	0.000	0.000	0.000	0.000
Equity, preference.	0.000	0.000	0.000	0.000	0.000	0.000
Subsidies, grants .	0.000	0.000	0.000	0.000	0.000	0.000
Loan A, foreign .	0.000	0.000	-21631.210	-24443.950	-27621.660	-31212.490
Loan B, foreign..	0.000	0.000	0.000	0.000	0.000	0.000
Loan C, foreign .	0.000	0.000	0.000	0.000	0.000	0.000
Loan A, local....	0.000	-4390.198	-4719.463	-5073.423	-5453.930	-5862.986
Loan B, local....	0.000	0.000	-6731.638	-7236.510	-7779.249	-8362.692
Loan C, local....	0.000	0.000	0.000	0.000	0.000	0.000
Total loan	0.000	-4390.198	-33082.910	-36753.880	-40354.240	-45438.150
Current liabilities	2055.000	496.250	1201.667	1158.333	2193.167	0.000
Bank overdraft	0.000	0.000	0.000	0.000	0.000	0.000
Total funds	2055.000	-3893.948	-31881.250	-35595.550	-38661.670	-45438.150

COMFAR 2.1 - UNIDO INVESTMENT PROMOTION SERVICES, POLAND --

Source of Finance, production in thousand of Syrian pounds

Year	2000
Equity, ordinary ..	0.000
Equity, preference.	0.000
Subsidies, grants .	0.000
Loan A, foreign .	-35270.100
Loan B, foreign..	0.000
Loan C, foreign .	0.000
Loan A, local....	0.000
Loan B, local....	-8989.910
Loan C, local....	0.000
Total loan	-44260.010
Current liabilities	0.000
Bank overdraft	0.000
Total funds	-44260.010

Cashflow Tables, construction in thousand of Syrian pounds

Year	1992	1993
Total cash inflow . .	53065.000	239027.500
Financial resources .	53065.000	239027.500
Sales, net of tax . .	0.000	0.000
Total cash outflow . .	53065.000	239027.500
Total assets	53065.000	237115.000
Operating costs . . .	0.000	0.000
Cost of finance . . .	0.000	1912.500
Repayment	0.000	0.000
Corporate tax . . .	0.000	0.000
Dividends paid . . .	0.000	0.000
Surplus (deficit) .	0.000	0.000
Cumulated cash balance	0.000	0.000
Inflow, local	33500.000	41012.500
Outflow, local	33500.000	41012.500
Surplus (deficit) .	0.000	0.000
Inflow, foreign . . .	19565.000	198015.000
Outflow, foreign . . .	19565.000	198015.000
Surplus (deficit) .	0.000	0.000
Net cashflow	-53065.000	-237115.000
Cumulated net cashflow	-53065.000	-290180.000

Cashflow tables, production in thousand of Syrian pounds

Year	1994	1995	1996	1997	1998	1999
Total cash inflow	106055.000	132496.300	194201.700	257158.300	331193.200	329000.000
Financial resources	2055.000	496.250	1201.667	1158.333	2193.167	0.000
Sales, net of tax	104000.000	132000.000	193000.000	256000.000	329000.000	329000.000
Total cash outflow	63457.680	90552.910	114156.200	128070.400	171353.400	261789.800
Total assets	9679.278	26429.270	5999.193	6013.334	9575.372	0.000
Operating costs	30710.000	36665.000	52335.000	66235.000	105953.000	105953.000
Cost of finance	23068.400	23063.400	22739.130	19068.170	14967.210	10383.900
Repayment	0.000	4390.198	33082.910	36753.990	40854.340	45438.160
Corporate tax	0.000	0.000	0.000	0.000	0.000	100014.800
Dividends paid	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit)	42597.320	41943.340	80045.430	129087.900	159839.700	67210.190
Cumulated cash balance	42597.320	84540.660	164586.100	293674.000	453513.800	520723.900
Inflow, local	105051.700	132227.500	193520.800	256441.700	330369.000	329000.000
Outflow, local	25736.170	30986.210	45805.170	50852.950	83446.910	180009.600
Surplus (deficit)	79315.500	101240.700	147715.700	205588.700	246922.100	148990.400
Inflow, foreign	1003.333	268.750	680.333	716.667	824.167	0.000
Outflow, foreign	37721.510	59566.110	68351.070	77217.440	87906.520	81780.210
Surplus (deficit)	-36718.180	-59297.360	-67670.230	-76500.770	-87082.350	-81780.210
Net cashflow	65665.720	69401.930	135867.500	184910.000	215661.300	123032.300
Cumulated net cashflow	-224514.300	-155112.300	-19244.880	165665.100	381326.900	504359.200

Cashflow tables, production in thousand of Syrian pounds

Year	2000	2001	2002	2003	2004	2005
Total cash inflow . .	329000.000	329000.000	329000.000	329000.000	329000.000	329000.000
Financial resources .	0.000	0.000	0.000	0.000	0.000	0.000
Sales, net of tax . .	329000.000	329000.000	329000.000	329000.000	329000.000	329000.000
Total cash outflow . .	258049.400	211159.700	211159.700	211159.700	211159.700	211159.700
Total assets	0.000	0.000	0.000	0.000	0.000	0.000
Operating costs . . .	105953.000	105953.000	105953.000	105953.000	105953.000	105953.000
Cost of finance . . .	5259.356	0.000	0.000	0.000	0.000	0.000
Repayment	44260.010	0.000	0.000	0.000	0.000	0.000
Corporate tax . . .	102577.000	105206.700	105206.700	105206.700	105206.700	105206.700
Dividends paid . . .	0.000	0.000	0.000	0.000	0.000	0.000
Surplus (deficit) .	70950.590	117840.300	117840.300	117840.300	117840.300	117840.300
Cumulated cash balance	591674.500	709514.800	827355.100	945195.400	1063035.700	1180876.000
Inflow, local	329000.000	329000.000	329000.000	329000.000	329000.000	329000.000
Outflow, local	176269.200	169234.700	169234.700	169234.700	169234.700	169234.700
Surplus (deficit) .	152730.800	159765.300	159765.300	159765.300	159765.300	159765.300
Inflow, foreign . . .	0.000	0.000	0.000	0.000	0.000	0.000
Outflow, foreign . . .	81780.210	41925.000	41925.000	41925.000	41925.000	41925.000
Surplus (deficit) .	-81780.210	-41925.000	-41925.000	-41925.000	-41925.000	-41925.000
Net cashflow	120470.000	117840.300	117840.300	117840.300	117840.300	117840.300
Cumulated net cashflow	624329.200	742169.500	860509.800	978350.100	1096190.100	1214031.000

Cashflow tables, production in thousand of Syrian pounds

Year	2006	2007	2008
Total cash inflow . .	329000.000	329000.000	329000.000
Financial resources .	0.000	0.000	0.000
Sales, net of tax . .	329000.000	329000.000	329000.000
Total cash outflow . .	211159.700	211159.700	211159.700
Total assets	0.000	0.000	0.000
Operating costs . . .	105953.000	105953.000	105953.000
Cost of finance . . .	0.000	0.000	0.000
Repayment	0.000	0.000	0.000
Corporate tax . . .	105206.700	105206.700	105206.700
Dividends paid . . .	0.000	0.000	0.000
Surplus (deficit) .	117840.300	117840.300	117840.300
Cumulated cash balance	1298716.000	1416557.000	1534397.000
Inflow, local	329000.000	329000.000	329000.000
Outflow, local	169234.700	169234.700	169234.700
Surplus (deficit) .	159765.300	159765.300	159765.300
Inflow, foreign . . .	0.000	0.000	0.000
Outflow, foreign . . .	41925.000	41925.000	41925.000
Surplus (deficit) .	-41925.000	-41925.000	-41925.000
Net cashflow	117840.300	117840.300	117840.300
Cumulated net cashflow	1331871.000	1449711.000	1567551.000

Cashflow Discounting:

a) Equity paid versus Net income flow:
Net present value .... 747555.30 at 9.00 %
Internal Rate of Return (IRRE1) .. 192.33 %

b) Net Worth versus Net cash return:
Net present value .... 724293.30 at 9.00 %
Internal Rate of Return (IRRE2) .. 192.67 %

c) Internal Rate of Return on total investment:
Net present value .... 668565.20 at 9.00 %
Internal Rate of Return (IRR) .. 36.01 %

Net Worth = Equity paid plus reserves

Net Income Statement in thousand of Syrian pounds

Year	1994	1995	1996	1997	1998
Total sales, incl. sales tax	104000.000	132000.000	193000.000	256000.000	329000.000
Less: variable costs, incl. sales tax.	0.000	0.000	0.000	0.000	0.000
Variable margin	104000.000	132000.000	193000.000	256000.000	329000.000
As % of total sales	100.000	100.000	100.000	100.000	100.000
Non-variable costs, incl. depreciation	47318.800	53279.800	70388.600	80848.600	120459.100
Operational margin	56681.200	78720.200	122611.400	175151.400	208540.900
As % of total sales	54.501	59.637	63.529	68.419	63.356
Cost of finance	23068.400	23068.400	22739.130	19068.170	14967.210
Gross profit	33612.800	55651.800	99872.270	156083.200	193573.700
Allowances	0.000	24020.000	0.000	0.000	0.000
Taxable profit	33612.800	31571.800	99872.270	156083.200	193573.700
Tax	0.000	0.000	0.000	0.000	0.000
Net profit	33612.800	55651.800	99872.270	156083.200	193573.700
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	33612.800	55651.800	99872.270	156083.200	193573.700
Accumulated undistributed profit	33612.800	89264.590	189136.900	345220.100	538793.800
Gross profit, % of total sales	32.320	42.160	51.747	60.970	58.837
Net profit, % of total sales	32.320	42.160	51.747	60.970	58.837
ROE, Net profit, % of equity	339.095	561.430	1007.539	1574.610	1952.824
ROI, Net profit+interest, % of invest.	19.033	24.316	37.321	52.537	61.196

Net Income Statement in thousand of Syrian pounds

Year	1999	2000	2001	2002	2003
Total sales, incl. sales tax	329000.000	329000.000	329000.000	329000.000	329000.000
Less: variable costs, incl. sales tax.	0.000	0.000	0.000	0.000	0.000
Variable margin	329000.000	329000.000	329000.000	329000.000	329000.000
As % of total sales	100.000	100.000	100.000	100.000	100.000
Non-variable costs, incl. depreciation	118586.600	118586.600	118586.600	118586.600	118586.600
Operational margin	210413.400	210413.400	210413.400	210413.400	210413.400
As % of total sales	63.955	63.955	63.955	63.955	63.955
Cost of finance	10383.900	5259.356	0.000	0.000	0.000
Gross profit	200029.500	205154.000	210413.400	210413.400	210413.400
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	200029.500	205154.000	210413.400	210413.400	210413.400
Tax	100014.800	102577.000	105206.700	105206.700	105206.700
Net profit	100014.800	102577.000	105206.700	105206.700	105206.700
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	100014.300	102577.000	105206.700	105206.700	105206.700
Accumulated undistributed profit	633802.500	741585.500	846592.200	951798.900	1057006.000
Gross profit, % of total sales	60.799	62.357	63.955	63.955	63.955
Net profit, % of total sales	30.400	31.178	31.978	31.978	31.978
ROE, Net profit, % of equity	1008.976	1034.325	1061.354	1061.354	1061.354
ROI, Net profit+interest, % of invest.	32.396	31.544	30.873	30.873	30.873

Damascus Foundry, base case --- August, 199?

Net Income Statement in thousand of Syrian pounds

Year	2004	2005	2006	2007	2008
Total sales, incl. sales tax	329000.000	329000.000	329000.000	329000.000	329000.000
Less: variable costs, incl. sales tax.	0.000	0.000	0.000	0.000	0.000
Variable margin	329000.000	329000.000	329000.000	329000.000	329000.000
As % of total sales	100.000	100.000	100.000	100.000	100.000
Non-variable costs, incl. depreciation	118586.600	118586.600	118586.600	118586.600	118586.600
Operational margin	210413.400	210413.400	210413.400	210413.400	210413.400
As % of total sales	63.955	63.955	63.955	63.955	63.955
Cost of finance	0.000	0.000	0.000	0.000	0.000
Gross profit	210413.400	210413.400	210413.400	210413.400	210413.400
Allowances	0.000	0.000	0.000	0.000	0.000
Taxable profit	210413.400	210413.400	210413.400	210413.400	210413.400
Tax	105206.700	105206.700	105206.700	105206.700	105206.700
Net profit	105206.700	105206.700	105206.700	105206.700	105206.700
Dividends paid	0.000	0.000	0.000	0.000	0.000
Undistributed profit	105206.700	105206.700	105206.700	105206.700	105206.700
Accumulated undistributed profit	1162212.000	1267419.000	1372626.000	1477833.000	1583039.000
Gross profit, % of total sales	63.955	63.955	63.955	63.955	63.955
Net profit, % of total sales	31.978	31.978	31.978	31.978	31.978
ROE, Net profit, % of equity	1061.354	1061.354	1061.354	1061.354	1061.354
ROI, Net profit+interest, % of invest.	30.873	30.873	30.873	30.873	30.873

Projected Balance Sheets, construction in thousand of Syrian pounds

Year	1992	1993
Total assets	53065.000	292092.500
Fixed assets, net of depreciation	0.000	53065.000
Construction in progress	53065.000	234527.500
Current assets	0.000	4500.000
Cash, bank	0.000	0.000
Cash surplus, finance available	0.000	0.000
Loss carried forward	0.000	0.000
Loss	0.000	0.000
Total liabilities	53065.000	292092.500
Equity capital	27565.000	87312.500
Reserves, retained profit	0.000	0.000
Profit	0.000	0.000
Long and medium term debt	25500.000	204780.000
Current liabilities	0.000	0.000
Bank overdraft, finance required	0.000	0.000
Total debt	25500.000	204780.000
Equity, % of liabilities	51.946	29.892

Projected Balance Sheets, Production in thousand of Syrian pounds

Year	1994	1995	1996	1997	1998
Total assets	327760.300	379518.100	447509.200	567996.900	722908.900
Fixed assets, net of depreciation	270983.700	254368.900	260395.300	245781.700	231275.600
Construction in progress	0.000	24080.000	0.000	0.000	0.000
Current assets	14068.450	16409.430	22382.790	28385.290	37754.500
Cash, bank	110.833	119.167	145.000	155.833	365.000
Cash surplus, finance available	42597.340	84540.660	164556.100	293674.100	453513.800
Loss carried forward	0.000	0.000	0.000	0.000	0.000
Loss	0.000	0.000	0.000	0.000	0.000
Total liabilities	327760.300	379518.100	447509.200	567996.900	722908.900
Equity capital	87312.500	87312.500	87312.500	87312.500	87312.500
Reserves, retained profit	0.000	33612.800	89264.590	159136.900	345220.100
Profit	33612.500	55651.800	99272.279	156053.200	193573.700
Long and medium term debt	204730.000	200389.800	167306.900	130553.000	89698.170
Current liabilities	[illegible]	2551.250	[illegible]	4911.250	7104.417
Bank overdraft, finance required.	0.000	0.000	0.000	0.000	0.000
Total debt	206535.000	202941.000	[illegible]	135464.300	96802.590
Equity, % of liabilities	26.639	23.006	19.511	15.372	12.078

Damascus Foundry, base case --- August, 19?

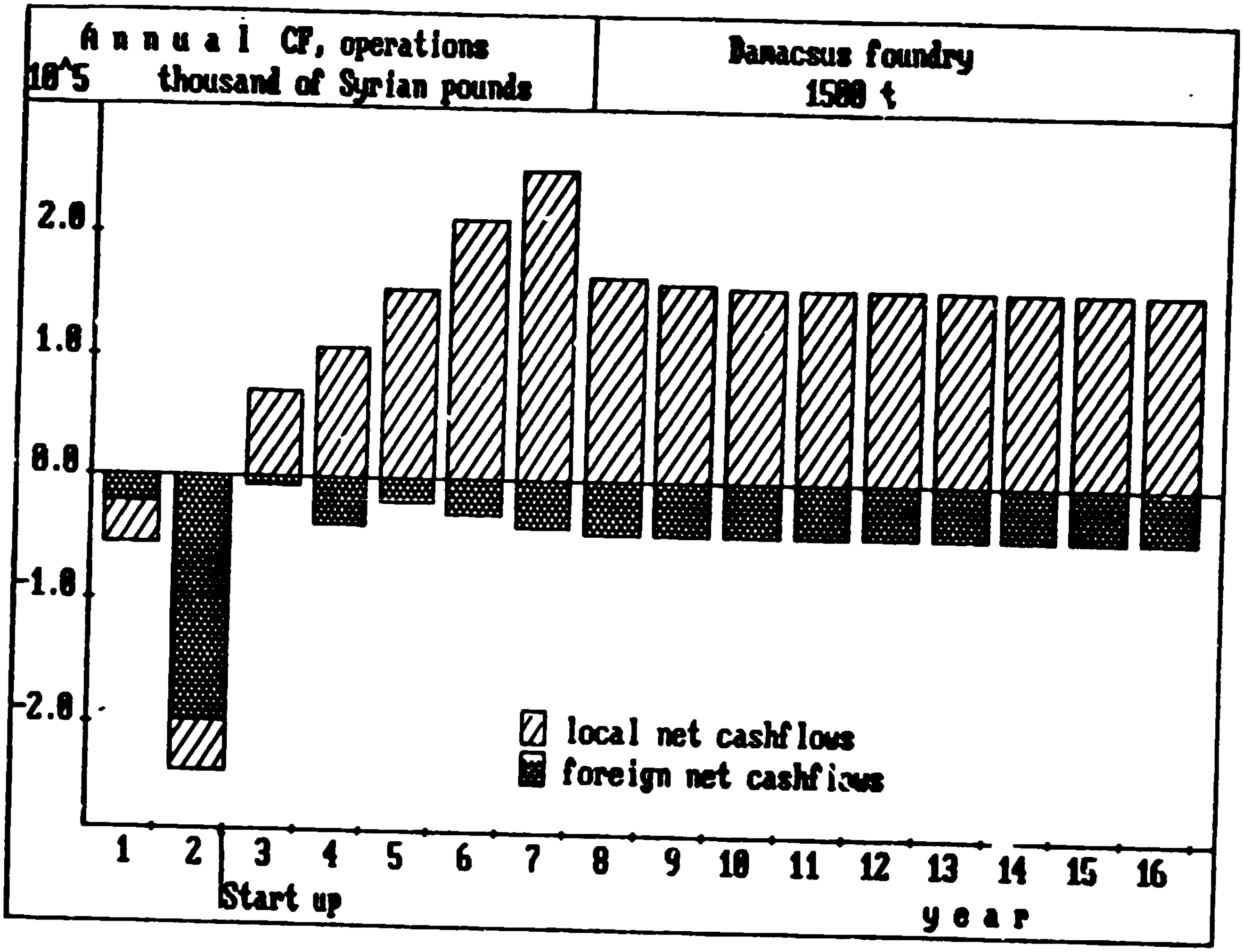
Projected Balance Sheets, Production in thousand of Syrian pounds

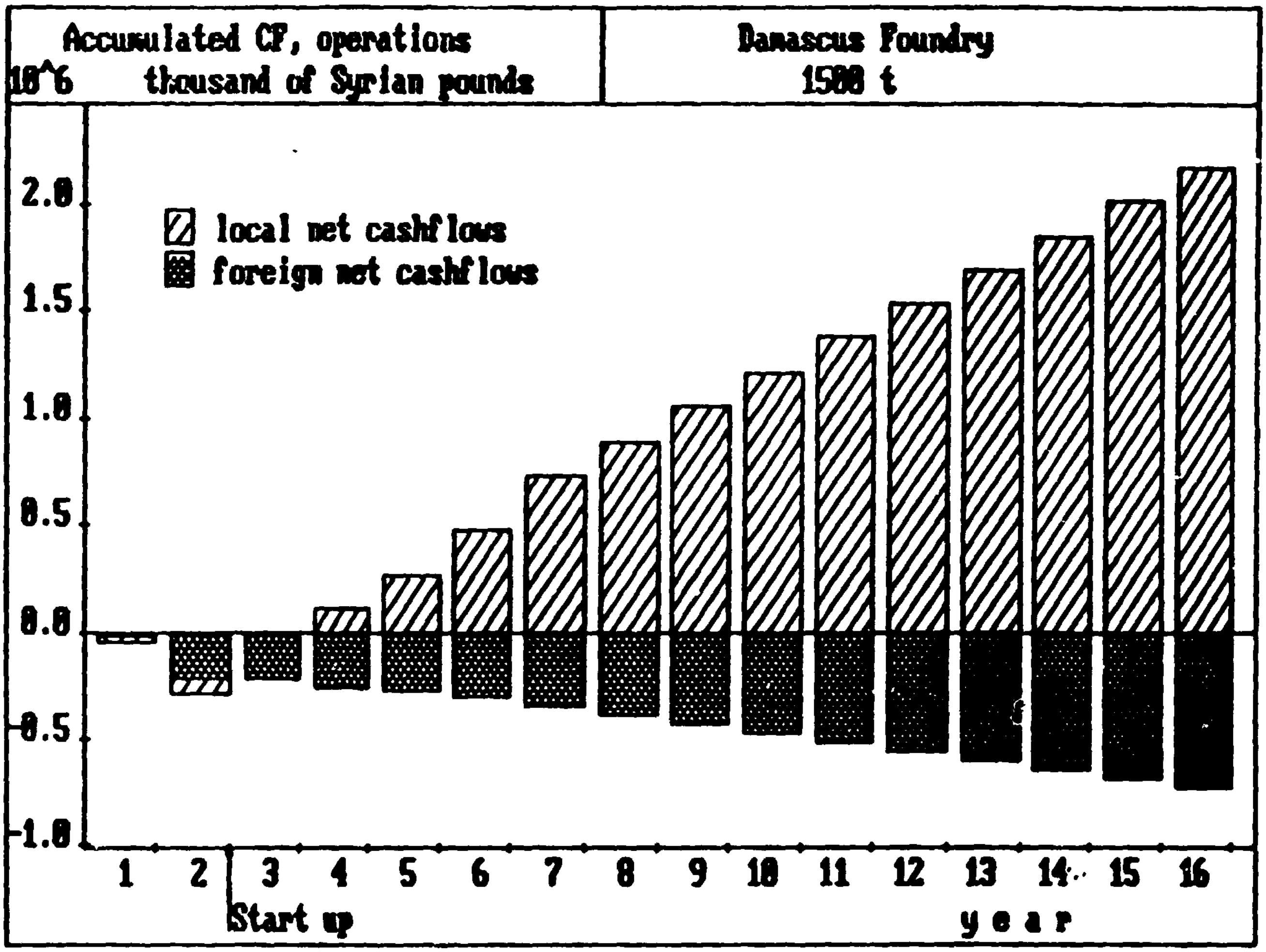
Year	1999	2000	2001	2002	2003
Total assets	777485.400	835802.400	941009.100	1046216.000	1151423.000
Fixed assets, net of depreciation	218642.000	206008.400	193374.800	180741.200	[illegible]
Construction in progress	0.000	0.000	0.000	0.000	0.000
Current assets	37754.500	37754.500	37754.500	37754.500	37754.500
Cash, bank	365.000	365.000	365.000	365.000	365.000
Cash surplus, finance available	520723.900	591674.300	709514.800	827355.100	945195.400
Loss carried forward	0.000	0.000	0.000	0.000	0.000
Loss	0.000	0.000	0.000	0.000	0.000
Total liabilities	777485.400	835802.400	941009.100	1046216.000	1151423.000
Equity capital	87312.500	87312.500	87312.500	87312.500	87312.500
Reserves, retained profit	538793.200	638808.500	[illegible]	946592.200	951798.900
Profit	100014.300	102577.000	105206.700	105206.700	105206.700
Long and medium term debt	44260.020	0.002	0.002	0.002	0.002
Current liabilities	7104.417	7104.417	7104.417	7104.417	7104.417
Bank overdraft, finance required.	0.000	0.000	0.000	0.000	0.000
Total debt	51364.430	7104.419	7104.419	7104.419	7104.419
Equity, % of liabilities	11.230	10.447	9.279	8.346	7.583

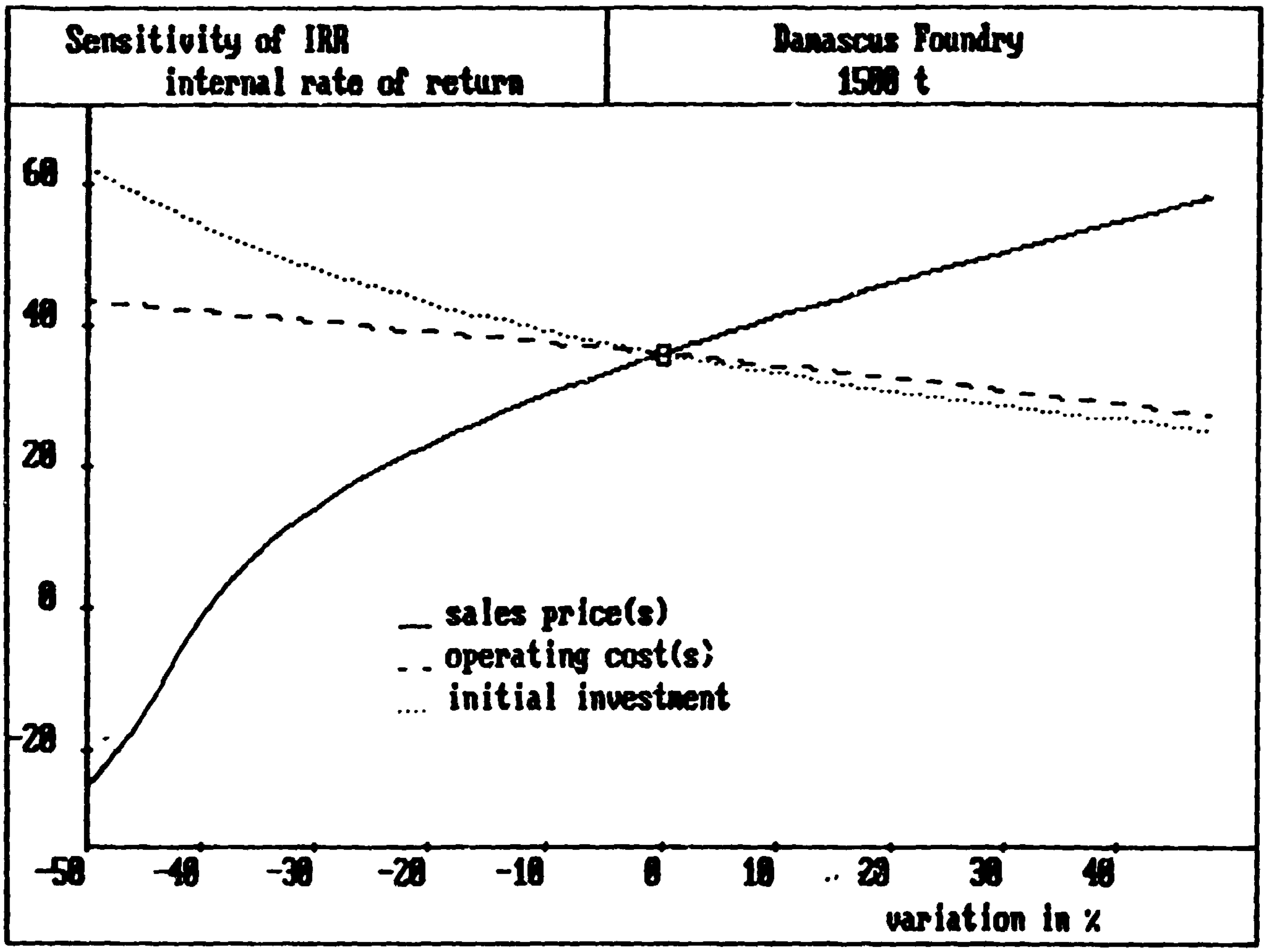
[illegible]

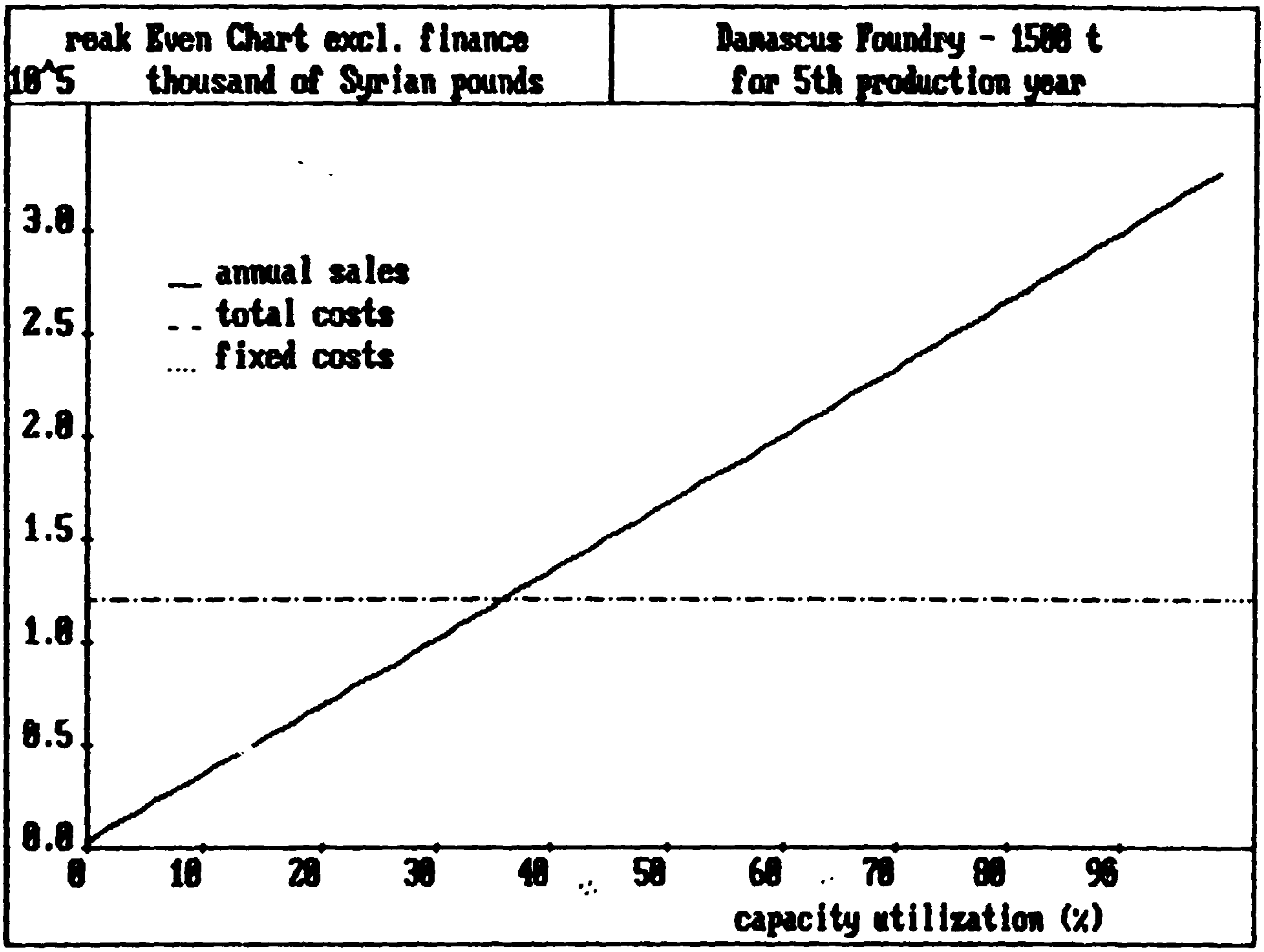
Projected Balance Sheets, Production in thousand of Syrian pounds

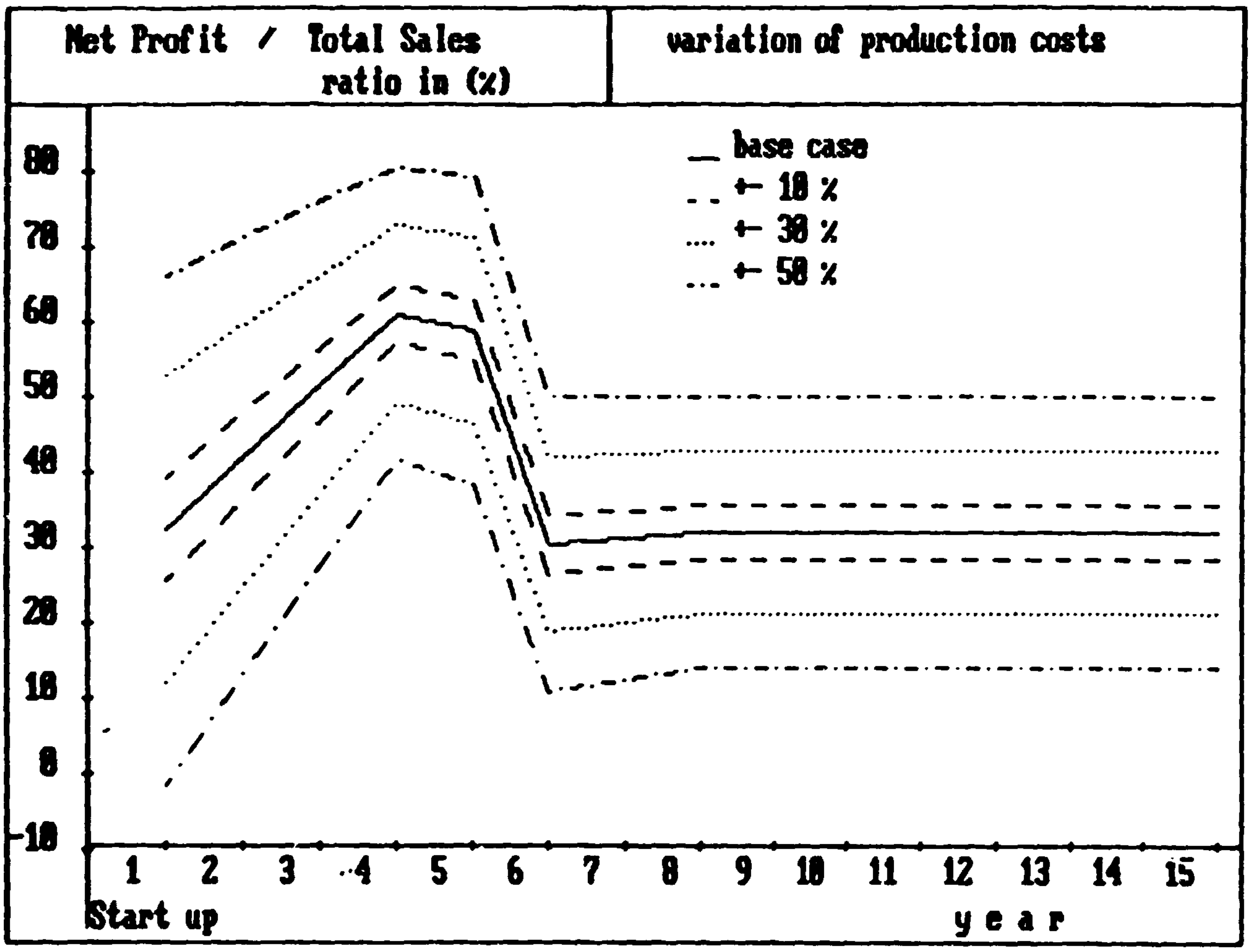
Year	2004	2005	2006	2007	2008
Total assets	1256629.000	1361836.000	1467043.000	1572250.000	1677456.000
Fixed assets, net of depreciation	155474.000	142840.400	130206.800	117573.200	104939.600
Construction in progress	0.000	0.000	0.000	0.000	0.000
Current assets	37754.500	37754.500	37754.500	37754.500	37754.500
Cash, bank	365.000	365.000	365.000	365.000	365.000
Cash surplus, finance available	1063036.000	1180876.000	1298716.000	1416557.000	1534397.000
Loss carried forward	0.000	0.000	0.000	0.000	0.000
Loss	0.000	0.000	0.000	0.000	0.000
Total liabilities	1256629.000	1361836.000	1467043.000	1572250.000	1677456.000
Equity capital	87312.500	87312.500	87312.500	87312.500	87312.500
Reserves, retained profit	1057006.000	1162212.000	1267419.000	1372626.000	1477833.000
Profit	105206.700	105206.700	105206.700	105206.700	105206.700
Long and medium term debt	0.002	0.002	0.002	0.002	0.002
Current liabilities	7104.417	7104.417	7104.417	7104.417	7104.417
Bank overdraft, finance required.	0.000	0.000	0.000	0.000	0.000
Total debt	[illegible]	7104.419	7104.419	7104.419	7104.419
Equity, % of liabilities	[illegible]	6.411	5.952	5.553	5.205


Annual CF, operations
10^5 thousand of Syrian pounds
Damacsus foundry
1500 t
2.0
1.0
0.0
-1.0
-2.0
local net cashflows
foreign net cashflows
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Start up
year

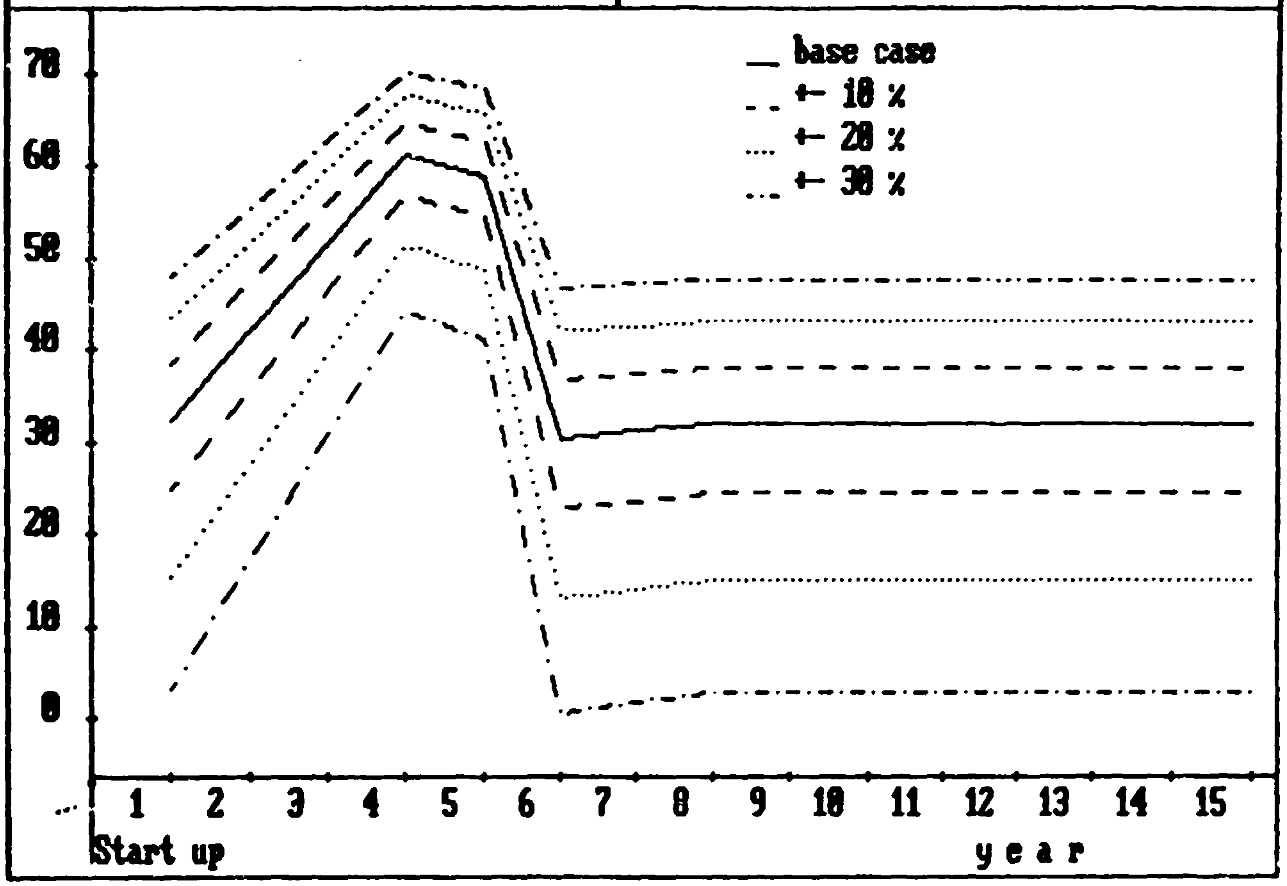

Accumulated CF, operations
10^6 thousand of Syrian pounds
Damascus Foundry
1500 t
local net cashflows
foreign net cashflows
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Start up
year

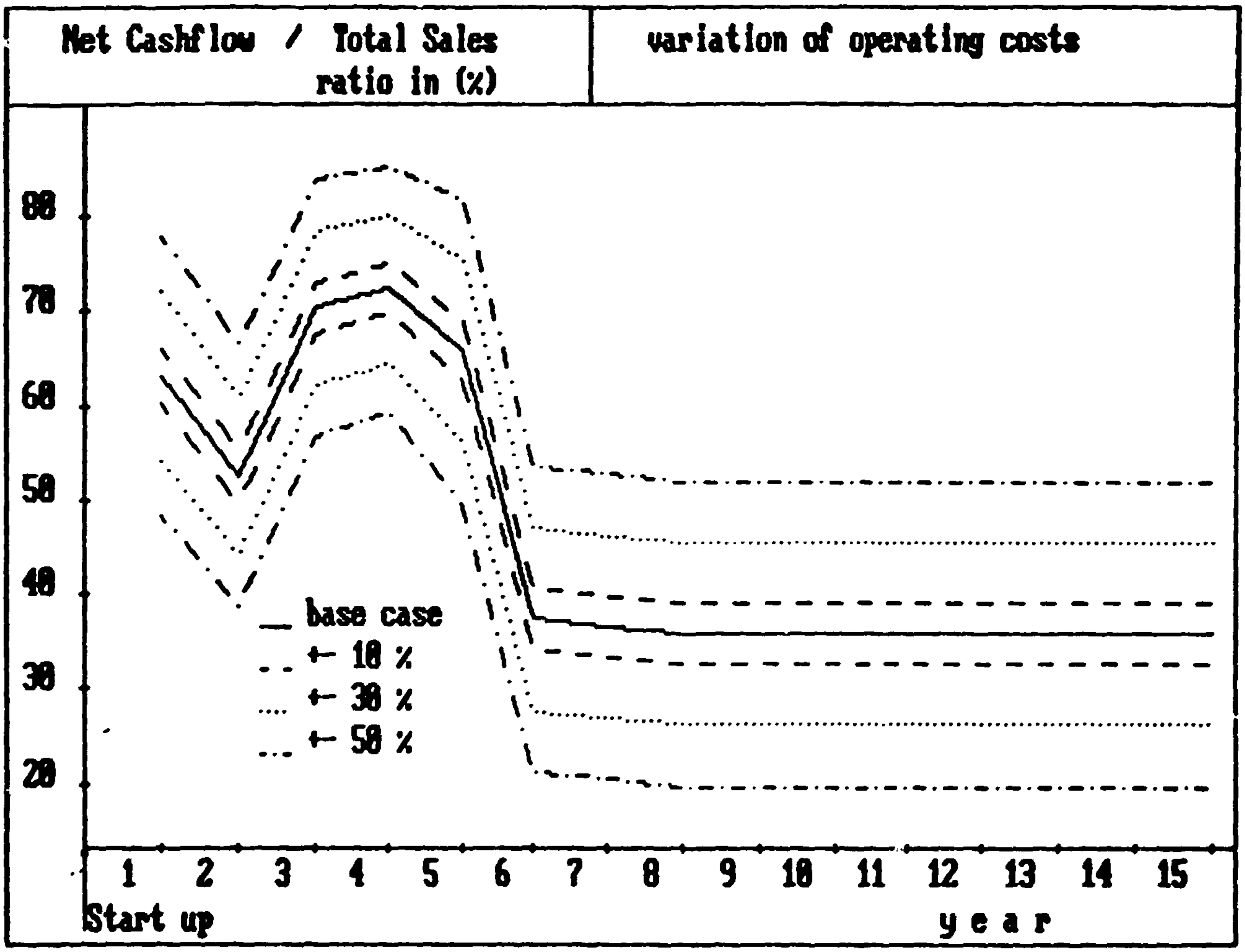

Sensitivity of IRR
internal rate of return
Damascus Foundry
1500 t
60
40
20
0
-20
-50
-40
-30
-20
-10
0
10
20
30
40
variation in %
__ sales price(s)
_ _ operating cost(s)
.... initial investment

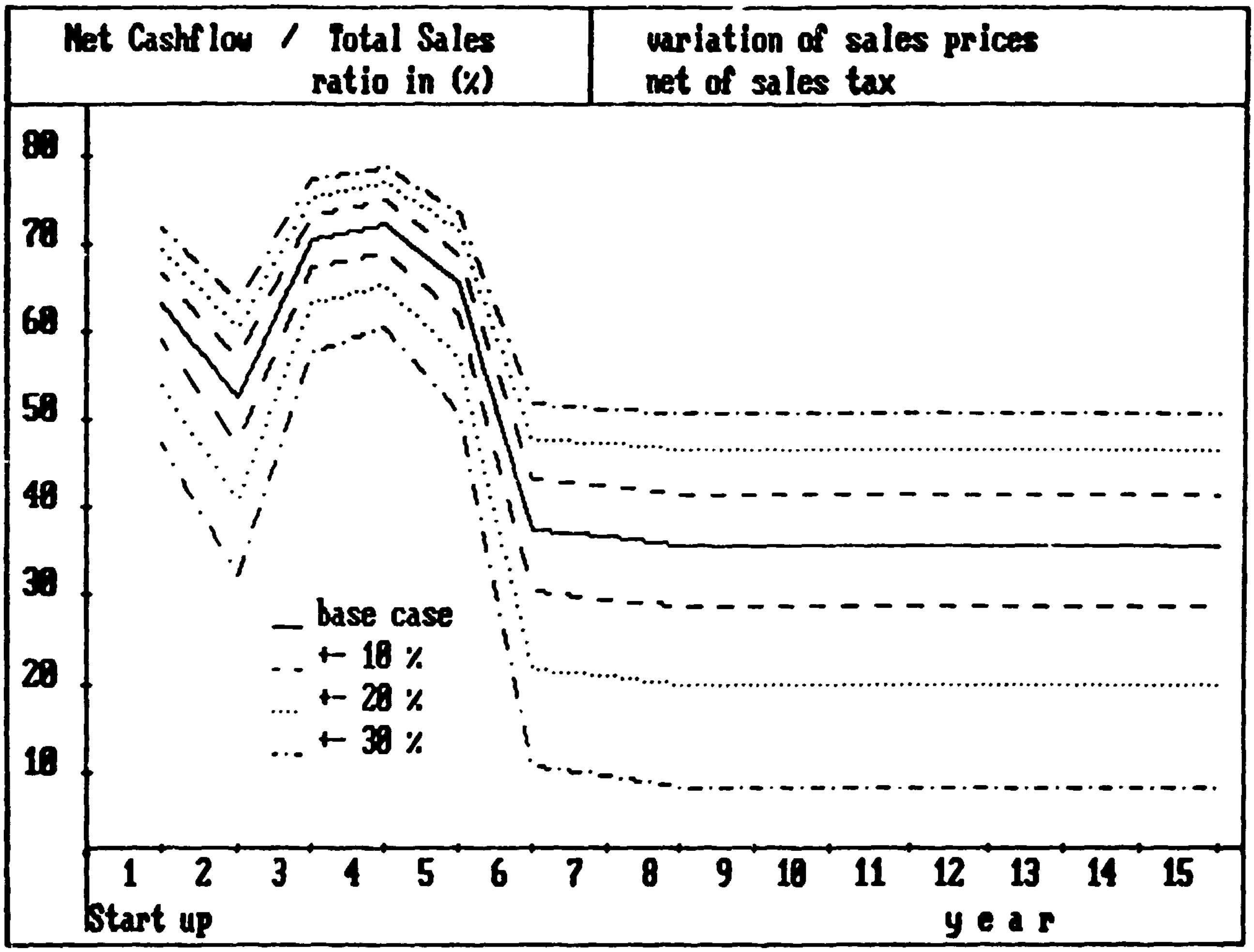

reak Even Chart excl. finance
10^5 thousand of Syrian pounds
Damascus Foundry - 1500 t
for 5th production year
3.0
2.5
2.0
1.5
1.0
0.5
0.0
— annual sales
- - total costs
.... fixed costs
0
10
20
30
40
50
60
70
80
90
capacity utilization (%)

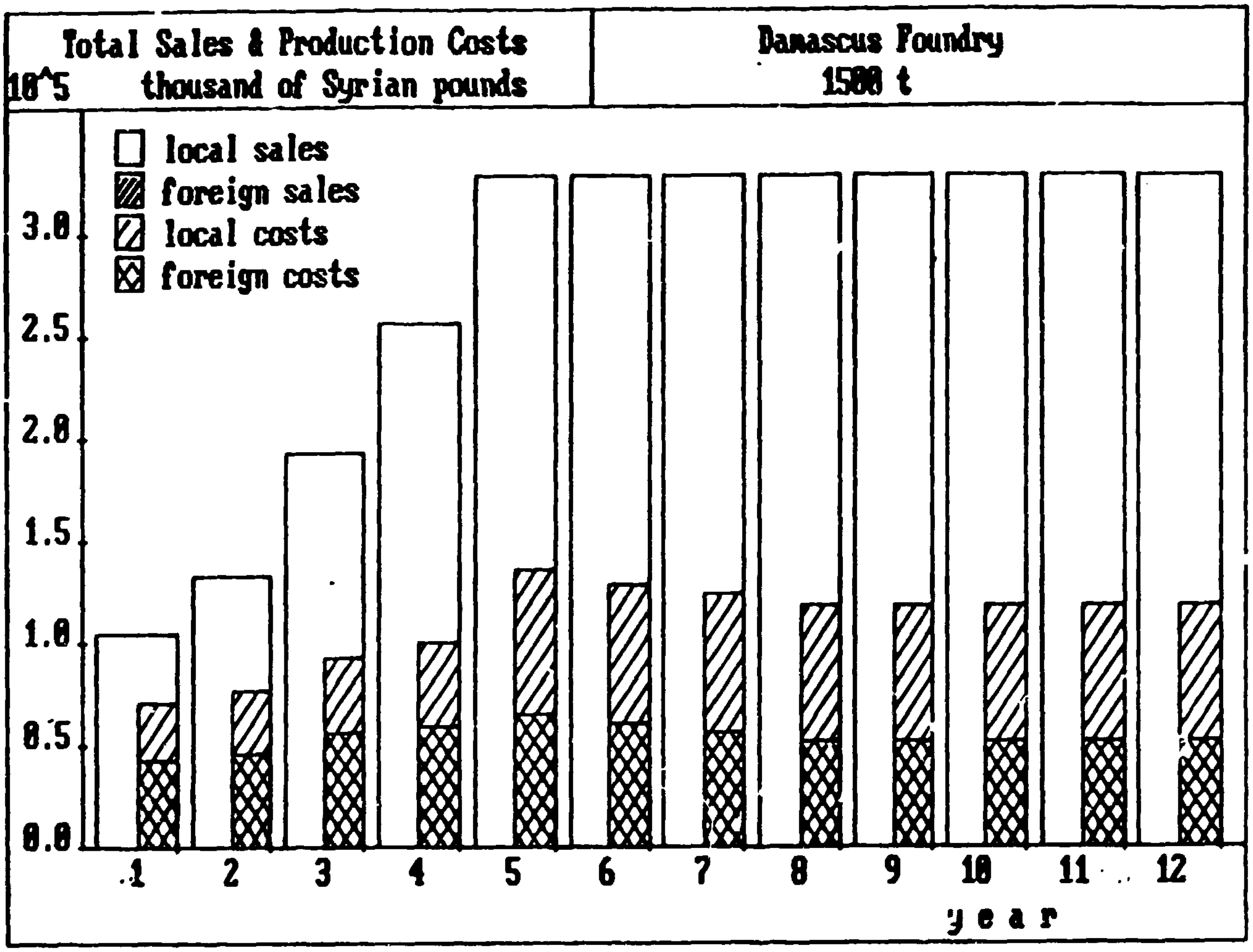

Net Profit / Total Sales ratio in (%)
variation of production costs
base case
+- 10 %
+- 30 %
+- 50 %
80
70
60
50
40
30
20
10
0
-10
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Start up
year

Net Profit / Total Sales ratio in (%)	variation of sales prices




Net Cashflow / Total Sales ratio in (%)
variation of operating costs
80
70
60
50
40
30
20
base case
+- 10 %
+- 30 %
+- 50 %
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Start up
year


Net Cashflow / Total Sales
ratio in (%)
variation of sales prices
net of sales tax
80
70
60
50
40
30
20
10
base case
+- 10 %
+- 20 %
+- 30 %
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Start up
year


Total Sales & Production Costs
10^5 thousand of Syrian pounds
Damascus Foundry
1500 t
local sales
foreign sales
local costs
foreign costs
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1
2
3
4
5
6
7
8
9
10
11
12
year

APPENDICES /ATTACHMENTS/

1. Results of Marketing Studies ....
2. Outlines for Designing Pilot Laboratories ....
3. Conceptual lay-outs of laboratory sections ....
4. Draft Project Document ....
5. List of Reference Documents/Publications ....
6. Institutions visited ....
7. BCIRA Report ....
8. Note on SSRC, the counterpart ....
9. List of Tables ....
10. Foundry Lay-outs ....

<u>Appendix 1</u>

RESULTS

OF MARKETING STUDIES

/iron castings/

<u>Table 1</u>	–	Estimated demand of castings as per the study of 1967
<u>Tables 2-15</u>	–	Demand of castings estimated by some major Syrian in 1991. /Results compiled by HpH S.A. - UNIDO Experts Team, May 1991/

SUMMARY OF ESTIMATED DEMAND

(Based on App. A & B).

Product Description	Type of Castings (Tons)			Total Product (Tons)
	Gray iron	Malleable iron	Cast Steel	
1. Centrifugal pipes	3,500	-	-	3,500
2. Pipe fittings (over 5 cm. dia.)	750	-	-	750
3. Soil pipe fittings	300	-	-	300
4. Drainage accessories	300	-	-	300
5. Drainage gates & valves	100	-	-	100
6. Sanitary fittings	500	50	-	550
" " (enameled)	200	-	-	200
7. Pipe fittings (under 5 cm. dia.)	-	350	-	350
8. Power transmission	25	-	-	25
9. Radiators	550	-	-	550
10. Hand operated m/c. tools				
- Meat mincers 4,000 Nos.	-	-	10	10
- Hand pumps 3,000 "	75	-	-	75
- Vises 1,600 "	-	-	30	30
- Anvils 600 "	-	-	35	35
11. Jobbing works	550	100	25	675
12. Motors, fans & ventilators	150	-	-	150
- Total casted products	7,000	500	100	7,600
13. Steel ingots	-	-	6,400	6,400
- Total annual production	7,000	500	6,500	14,000

This table is taken from a study prepared by Su dhans S.Polit,UN industrial engineer and others 18 Feb. 1967 .

Table (2)

Annual Consumption for : Agricultural Mechanisation

Of The Steel and cast iron castings

No.	Name of piece	Material		Appro. Weight (KG)	Appro. Dimensions (MM)	Unit.Price in S.P. or foreign cur.	Quantity (PES)	Annual req.Qty	Remarks
		Cast iron	Cast steel						
1	Truck chain plate		C.Steel	25	560x350x50	2000	1000	25	
2	Truck chain piece		C.steel	8 kg	300x120	3000	2000	16	
3	Chain pin		C.steel	3	250xø25	1500	2000	6	
4	Chain bushing		"	2	200x40	100	2000	4	
5	Chain pulley	grey iron		40	-	25000	150	6	
6	Two-strand chain pulley	"		50	-	30000	200	10	
7	Upper chain pulley	"		25	-	25000	100	2.5	
8	Scarifier		C.steel	300	80th. leng.1500	800000	10	3	
9	Scarifier's tips		C.steel	60	300x80x500	35000	30	2	
10	Scarifier's teeth		C.steel	70	300x100	4000	1000	70	
	Sub.Total							126	Cast steel
								18.5	Cast Iron.

Annual Consumption for : Agricultural Mechanisation

Of The Steel and cast iron castings

No.	Name of piece	Material		Appro. Weight(KG)	Appro. Dimensions(MM)	Unit.Price in S.P. or foreign cur.	Quantity (PES)	Annual req.Qty	Remarks
		Cast iron	Cast steel						
11	Adapter		C.Steel	1	Ø 20 x 150	1000	1000	1	
12	Scarifier's cover		C.Steel	10	length 400	2000	150	1.5	
13	Pump fan	grey iron		3	Ø 200	300	6	0.018	
14	Pump flange	"		6	Ø 250	300	15	0.09	
15	Pulley	"		2 - 40	Ø 100 - 500	500 - 20000	150	3	
16	Chain linking part		C.Steel	40	20x60x30	20 000	5	0.2	
17	Truck chain wheel	"		15	-	-	5	0.075	
18	Sprocket		C.steel	4 - 20	-	-	600	6	
19	Auto plow disc	"		10	Ø200	-	50	0.5	
20	Auto plow wheel	"		20	Ø400	-	20	0.4	
	Sub.Total							134.7T.	Cast steel
								22.7T.	Cast iron

Annual Consumption for : Agricultural Mechanisation
Of The Steel and cast iron castings

No.	Name of piece	Material		Appro. Weight(KG)	Appro. Dimensions(MM)	Unit.Price in S.P. or foreign cur.	Quantity (PES)	Annual req.Qty	Remarks
		Cast iron	Cast steel						
21	Harvester parts		C.steel	-	-	-	-	1	
22	Spare parts		C.steel	13	650x300x60	585	346	4.5	
23	Sweeper armes		C.steel	5 - 13	-	-	50	0.5	
24	Plow blade's armes		C.steel	20 -45	-	-	116	3.5	
25	Tips		C.steel	800	-	-	23	18	
26	Linking pieces		C.steel	5	200x150x150	225	400	2	
27	Flanges	grey iron		2 - 10	Ø 400 - 600	-	130	1.3	
28	Pulley	-		2 - 57	200 - 2000		140	5.6	
29	Gears		C.steel	1.5- 10	Ø160x30 -Ø250		260	2.5	
	Sub.Total							166.7	Cast steel
								29.7	Cast iron

Annual Consumption for : Agricultural Mechanisation

Of The Steel and cast iron castings

No.	Name of piece	Material		Appro. Weight(KG)	Appro. Dimensions(MM)	Unit.Price in S.P. or foreign cur.	Quantity (PES)	Annual req.Qty	Remarks
		Cast iron	Cast steel						
30	Chains		C.steel	20 - 70	-	-	45	2.25	
31	Dryer spiral		C.steel	30 - 50	Ø 50 - 80 L 5000-12000	-	60	2.4	
32	Housing	grey iron		3			150	0.45	
33	Cylinder pulley	"		40 - 60	Ø 45 L 50 Ø 45 L200		40	2	
34	Mescilleneous		C.steel	-	-	-	-	1	
	Total :							172.35 32.15	Cast steel Cast iron Ton.

Table (3)

Annual Consumption for : CEMENT COMPANY

Of The Steel and cast iron castings

No.	Name of piece	Material		Appro. Weight (KG)	Appro. Dimensions (MM)	Unit.Price in S.P. or foreign cur.	Quantity (PES)	Annual req.Ton	Remarks
		Cast iron	Cast steel						
1	Cooler Plate		all. Steel	50	300X400X35		10 000	500	
2	Furnace Plate		all. Steel	90	500X300X30		1 012	100	
3	Crusher Ball		= =	(0.3 - 3)	ϕ (60 - 90)		700 000	1 000	
4	Crusher Ball		= =	(0.06-0.5)	ϕ (25-50)		1 000 000	500	
5	Standard - Steps		Alloyed Steel	47-118KG	400X440 - 737X440		100	7.5	
6	Tower		=	90 - 220			2 000	270	
7	Rings		=	10			100	1	
8	Gears		=	160 - 250			20	4	
9	Pulleys			10			50	0.5	
	TOTAL							2383 Ton	Steel

GENERAL ESTABLISHMENT OF Chemical Industries.

Annual Consumption for :

Of The Steel and cast iron castings

No.	Name of piece	Material		Appro. Weight (KG)	Appro. Dimensions (MM)	Unit.Price in S.P. or foreign cur.	Quantity (PES)	Annual req.ton	Remarks
		Cast iron	Cast steel						
1	Pump coupling	X grey		180	1150	1150	50	9	
2	Pump seals	x grey		20		95	300	6	
3	Engine base cover		C.Steel	200		1760	50	10	
4	Vibrators'arm	grey		50		750	60	3	
5	Ingine support	grey		25		50	200	5	
6	Valve cover	grey		20		240	250	5	
7	Gears		C.Steel	5-125		3700	500	25	
8	Cooling System	grey		150-250		1120	20	4	
	Base plate								
9	Pump housing	grey		170-300		2475	20	5	
	SUB.TOTAL							35 T	Cast Steel
								37 T	Cast Iron.

GENERAL ESTABLISHMENT OF CHEMICAL INDUSTRIES

Annual Consumption for :

Of The Steel and cast iron castings

No.	Name of piece	Material		Appro. Weight(KG)	Appro. Dimensions(MM)	Unit.Price in S.P. or foreign cur.	Quantity (PES)	Annual req.ton	Remarks
		Cast iron	Cast steel						
10	Ingine Cover for lifter		C.Steel	100-175		3950	7	1	
11	Rubber die-Casting	grey		25-75		560	20	1	
12	Pump axe bou.ing	grey		30-50		1600	250	10.5	
13	Rubber die-casting for poiler fans .	grey		25-50		1200	50	2	
14	Gear box body	grey		100-200		1640	10	1.5	
15	Arm of lifting machine		C.Steel	25-100		560	25	1	
16	Oil container,s Cover.	grey		10-50		-	100	4	
	Sub.Total.							37 T	Cast Steel
								56 T	Cast Iron

GENERAL ESTABLISHMENT OF CHEMICAL INDUSTRIES

Annual Consumption for : FERTILIZER FACTORY

Of The Steel and cast iron castings

No.	Name of piece	Material		Appro. Weight (KG)	Appro. Dimensions (MM)	Unit.Price in [redacted] or foreign cur.	Quantity (PES)	Annual req.ton	Remarks
		Cast iron	Cast steel						
1	Pump Impellers		All. Steel	2 - 25			100	1.5	
2	Pump Bodies		=	10 - 50			50	2	
3	Bodies Covers		=	5 - 30			50	1	
4	Sleeves, Bushes		=	0.2 - 5			500	1.5	
5	Bearing Bodies		=	2 - 10			120	1	
6	Couplings		=	2 - 20			200	2	
	SUB TOTAL							46 56	Ton Cast Steel = = Iron

GENERAL ESTABLISHMENT OF CHEMICAL INDUSTRIES

Annual Consumption for : FERTILIZER FACTORY

Of The Steel and cast iron castings

No.	Name of piece	Material		Appro. Weight(KG)	Appro. Dimensions(MM)	Unit.Price in S.P. or foreign cur.	Quantity (PES)	Annual req. ton	Remarks
		Cast iron	Cast steel						
1	Pump Impellers	Grey Cast Iron		2 - 25	ϕ 150 - 400	100 - 50000	150	2	
2	Pump Bodies	= =		10 - 50	ϕ 200 - 700	5000 - 60000	75	2.5	
3	Bodies Covers	= =		5 - 30	ϕ 200 - 700	5000	50	1	
4	Sleeves , Bushes	= =		0.2- 5	ϕ 70 - 150	100 - 1000	500	1.5	
5	Bearing Bodies.	= =		2 - 10	ϕ 100 - 300	1000 - 25000	150	1	
6	Couplings	= =		2 - 20	ϕ 80 - 300	500 - 20000	200	2	
7	Wheels - Toothed wheel	= =		20 kg	ϕ 80 - 300	500 - 20000	200	4	
				2 - 40	ϕ 150 - 700	500 - 20000	500	10	
8	El. Motors Covers + Fans	= =			Thickner 30 - 200				
	TOTAL							46 T 00 T	Cast Steel Cast Iron

Table (5)

Annual Consumption for : Food industries
Of The Steel and cast iron castings

No.	Name of piece	Material		Appro. Weight (KG)	Appro. Dimensions (MM)	Unit.Price in S.P. or foreign cur.	Quantity (PES)	Annual req. Ton	Remarks
		Cast iron	Cast steel						
1	Tomato smashing machine parts.	Cast.Iron	--	3-15	100x300 Ø	1500	50	0.5	
2	Counpling	=	--	5-15	120x250 Ø	2000	50	0.5	
3	Tomato's smashing tools	=	--	1-5	80 - 250	8000	110	0.5	
4	Gears	=	--	2-40	80x 500 Ø	9000	100	2.5	
5	Covers	=	--	2-25	x 350 Ø	2000	40	0.5	
6	Teethed Wheel	=	--	2-35	Ø300	3000	150	3	
7	Sterilization Container's Coveres	=	--	50-150	Ø1000	7000	100	10	
8	Out -let Covers of Vapour	=	--	5-25	Ø 200	2 1200	30	0.5	
9	Various Gears	=	--	1-15	Ø 100-500	2000-10 000	100	1	
10	Flanges	=	--	1-50	Ø 100-1500	300- 1000	120	3	
	Total							22 T	Cast Iron

Table(6)

GEOLOGICAL ESTABLISHMENT

Annual Consumption for :

Of The Steel and cast iron castings

No.	Name of piece	Material		Appro. Weight(KG)	Appro. Dimensions(MM)	Unit.Price in S.P. or foreign cur.	Quantity (PES)	Annual req.Qty Ton.	Remarks
		Cast iron	Cast steel						
1	Driving gear		x	180			15	2.7	
2	Bushing	x		25			28	0.7	
3	Spacer bush	x		14			48	0.7	
4	Gears		x	26			50	1.3	
5	Handle shifter	x		40			12	0.5	
6	Fork		x	62			72	4.5	
7	Bearing cap		x	70			50	3.5	
8	Guide	x		30			16	0.5	
9	Cylinder	x		100			25	2.5	
10	Socket	x		32			50	1.6	
11	Cover	x		80			50	4	
12	Spacer	x		12			25	0.30	
13	Clutch twin disc	x		200			48	9.6	
	Sub.Total.							12TC.St.	18.5 TC.T

GEOLOGICAL ESTABLISHMENT

Annual Consumption for :

Of The Steel and cast iron castings

No.	Name of piece	Material		Appro. Weight(KG)	Appro. Dimensions(MM)	Unit.Price in S.P. or foreign cur.	Quantity (PES)	Annual req.Qty	Remarks
		Cast iron	Cast steel						
14	Driving for pump	x		100			12	1.2	
15	Driving plate	x		30			120	3.6	
16	Center plate	x		50			24	1.2	
17	Gears		x	130			15	2	
18	Ball bearing housing.		x	25			120	3	
19	Cone		x	140			25	3.5	
20	Cylinder block	x		175			12	2.1	
21	Gears		x	20			25	0.5	
22	Protected ball thrust bearing	x		15			432	6.4	
23	Pick set for diggers.		x	250			720	180	
	Total.							201T	Cast Steel
								33T	Cast Iron

Table (7)

Annual Consumption for . KASSIOUN Co .

Of The Steel and cast iron castings

No.	Name of piece	Material		Appro. Weight (KG)	Appro. Dimensions (MM)	Unit.Price in S.P. or foreign cur.	Quantity (PES)	Annual req.Ton	Remarks
		Cast iron	Cast steel						
1	Inspection Cover Round or square	Grey Cast Iron		180	800 X 800	9 000	1 800	324	
2	Flat Grating	Ductile Cast Iron		77	550 X 500	3 500	1 200	92	
3	Mould for tile or Concrete Blocks	=		34	400 X 400	3 000	300	10	
4	Baled for Graders or Buldozer		Special Steel	20 - 50	Various	7 200	600	21	
5	teeth for Traxcavator,s Basket: or similar		=	25 - 50	=	16 000	900	36	
6	Crushing Plate for Crushers		=	150	=	32 000	120	18	
	TOTAL							426 65	Ton Cast Iron = steel

Table (8)

Annual Consumption for : Marble Factory

Of The Steel and cast iron castings

No.	Name of piece	Material		Appro. Weight (KG)	Appro. Dimensions (MM)	Unit.Price in S.P. or foreign cur.	Quantity (PES)	Annual req.Qty	Remarks
		Cast iron	Cast steel						
1	Rails for marble cutting machine	-	x	60	945x95x95		50	3 Ton	
2	Bushing	x	-	5	Ø 110-140	-	300	1.5Ton	
3	Bearing cap	x	-	5	-	-	100	0.5Ton	
4	Gears	x	-	5 - 100	Ø100-500	-	300	1.5Ton	
5	Wheel	x	-	100 - 350	Ø60-600	-	200	5 Ton	
6	Gear box	x	-			-	50		
7	Grinding disc	x	-	5	Ø 120	-	100	0.5Ton	
8	Flanges	x	-	3 - 20	Ø100-300	-	100	1.5Ton	
9	Pully	x	-	20 - 50	-		50	2 Ton	

Total:

3 Cast steel
9.5 Cast Iron.

Table (9)

(M. A. T. A) COMPANY

Annual Consumption for : VEHICILE,S ENGINE REPAIRING SECTION
Of The Steel and cast iron castings

No.	Name of piece	Material Cast iron	 Cast steel	Appro. Weight (KG)	Appro. Dimensions (MM)	Unit.Price in S.P. or foreign cur.	Quantity (PES)	Annual req. Ton	Remarks
1	Mixer Pully	Grey Iron		20	Φ 300 Thick 100	4 000	250	5	
2	Crane Pully	= =		10	Φ 500 = 60	4 500	500	5	
3	Mixer Axes		C. Steel	30	Φ 200 L. 400	6 000	175	5.5	
4	Sprocket		=	50	260	2 000	300	15	
5	Piston and Cylinder	= =		4	int Φ 95	200	1 500	6	
6	Balancing Wheel		=	10	ext Φ 400	3 000	300	3	
7	Crank Shaft	S.G.Iron 30 %	= 70 %	30 - 100		15000-50000	600	36	
	TOTAL							27 48.5	Ton Cast Iron = Cast Steel

Table (10)

Annual Consumption for : Mili-House
Of The Steel and cast iron castings

No.	Name of piece	Material		Appro. Weight(KG)	Appro. Dimensions(MM)	Unit.Price in S.P. or foreign cur.	Quantity (PES)	Annual req.Qty Kg.	Remarks
		Cast iron	Cast steel						
1	Gears		x	110	1200x300		3	330	
	"		x	100	1000x300		2	200	
	"		x	85	900x20		7	595	
2	Pully		x	60	1200x300		3	180	
3	Pully		x	45	350x100		12	540	
4	Coupling		x	10	350x300		7	70	
5	Furnace hole cone		x	10	-		10	100	
6	Control hole cone	x		25	-		10	250	
7	Pusher mass		x	15	-		10	150	
8	Melted metal guide		x	5	-		10	50	
9	Mixer speral		x	20	-		20	400	
10	Different casting for crusher factory.		x	5-50	-		100	3000	
11	Pully		x	2	ø 200		250	500	

Sub.Total

3415 kg Cast Steel
250 Kg Cast Iron

Annual Consumption for : Mili house

Of The Steel and cast iron castings

No.	Name of piece	Material		Appro. Weight(KG)	Appro. Dimensions(MM)	Unit.Price in S.P. or foreign cur.	Quantity (PES)	Annual req.Qty Kg	Remarks
		Cast iron	Cast steel						
12	Cylinder pully		x	10	Ø 200		6	60	
13	Cylinder die		x	250	Ø500x1200		6	1500	
14	Gears		x	50	Ø400x100		6	300	
15	Crusher plate		x	80	400x250x120		200	1600	
16	"		x	40	200x250x120		150	6000	
17	Cooling blade		x	16	200x200x30		100	1600	
18	Gears	x	x	0.3-100	-		500	25000	
19	Speral's blade		x	12	-		150	1800	
20	Speral blade holder	x	-	100	-		10	1000	
21	Injection blade		x	15			200	3000	
22	Injection blades holder.	x		85	-	-	10	850	
23	Pully	x		32	Ø 300	3150	22	700	
24	Syfon	x		8	Ø4"- Ø6"	750	25	200	

Sub.Total — 43700Kg Cast Steel; 28000Kg Cast Iron.

Annual Consumption for : Mili House

Of The Steel and cast iron castings

No.	Name of piece	Material		Appro. Weight(KG)	Appro. Dimensions(MM)	Unit.Price in S.P. or foreign cur.	Quantity (PES)	Annual req.Qty kg.	Remarks
		Cast iron	Cast steel						
25	Wheel	x		18	Ø400	1800	100	1800	
26	Cover	x		80	600x600	5384	120	9600	
27	Gears	x		80	Ø 1200	8000	18	1440	
28	Cylinder busher	x		12	Ø 100	120	30	360	
	Sub. Total							43700 Kg =43.7T	Cast Steel
								41200Kg =41.2T	Cast Iron.

Annual Consumption for : Milli House

Of The Steel and cast iron castings

No.	Name of piece	Material		Appro. Weight(KG)	Appro. Dimensions(MM)	Unit.Price in S.P. or foreign cur.	Quantity (PES)	Annual req.Qty	Remarks Ton.
		Cast iron	Cast steel						
1	Transporting Wheel	grey		32	Ø (200-350)	3150		22	0.7
2	Trolley Wheel	x		18	Ø 40	1800		100	1.8
3	Trolley Wheel	x		40	Ø 400	4000		150	6
4	Plate	x		80	600 x 600	5384		120	9.6
5	Gear	x		80	Ø 1200	8000		100	8
6	Cover	x		12	Ø 100	120		85	1
7	Siphon	x		8	Ø 4" - Ø6"	750		25	0.2
	Sub.Total							43.7 T	Cast Steel
								68.5 T	Cast Iron.

Annual Consumption for : MILI HOUSE

Of The Steel and cast iron castings

No.	Name of piece	Material		Appro. Weight (KG)	Appro. Dimensions (MM)	Unit.Price in S.P. or foreign cur.	Quantity (PES)	Annual req. Ton	Remarks
		Cast iron	Cast steel						
1	Balancing Block	Grey		2 700		54 000	29	78.3	
2	Crank Shaft	S.G Iro 20 %	C. Steel 180%	2 500		50 000	10	25	
3	Rigars	-		50 - 300		1000 - 6000	250	50	
4	Gear-Box	-		50			200	10	
5	Pipes	-		50			1 000	50	
6	Gears	-	C. Steel	15 - 80			200	8	
7	Different Parts of Spares	Grey Iron		10 - 20			3333	50	
8	Transporting Wheel	Grey Iron		32			80	2.5	
	TOTAL							71.7	Ton Cast Steel
								314.3	Ton Grey Iron

Table 11

Annual Consumption for : port Company.

Of The Steel and cast iron castings

No.	Name of piece	Material		Appro. Weight (KG)	Appro. Dimensions (MM)	Unit.Price in S.P. or foreign cur.	Quantity (PES)	Annual req.Qty Ton.	Remarks
		Cast iron	Cast steel						
1	Pulleys	grey iron		2 - 20	100 - 400		150	0.5	
2	Gears	S.G iron50%	Steel 50%	1 - 60	100 - 500		200	10	5
3	Couplings	grey iron	-	2 - 10	60 - 300		150	1	
4	Crank shaft	SG iron50%	C.Steel 50%	50			150	5	2.5
5	Parts	grey iron70%					3		2
6	Cylinders	x		5	Ø 60 - 100		200	1	
7	Mechnismes	x	x 50%	0.5 - 20	-		-	2	1
8	Chain	-	x					1	
9	Miscellaneous	x 50%	x 50%					10	5
	Total:							15 T. 15.5T.	Cast Steel Cast Iron.

Table 12

Annual Consumption for : RAIL WAYS ASSOCIATION

Of The Steel and cast iron castings

No.	Name of piece	Material		Appro. Weight (KG)	Appro. Dimensions (MM)	Unit. Price in S.P. or foreign cur.	Quantity (PES)	Annual req. Ton	Remarks
		Cast iron	Cast steel						
1	Brake Shoes	grey		14	-	500	43 000	600	
2	- -	-		8		280	50 000	400	
3	Piston Crown	Special	Steel	20		500 $	500	10	
4	Fastener	C.	Steel	8		25 $	3 100	25	
5	Teethed Wheel	C.	Steel (0.45C)	150		2 250 $	100	15	
6	Turbine Blades	Alloyed	Steel	0.4		100 $	2 500	1	
	TOTAL							51 Ton 1000 -	Cast Steel Cast Iron

GENERAL ESTABLISHMENT OF PETROL

Table 13

Annual Consumption for : REFINERY

Of The Steel and cast iron castings

No.	Name of piece	Material		Appro. Weight (KG)	Appro. Dimensions (MM)	Unit.Price in S.P. or foreign cur.	Quantity (PES)	Annual req.Ton	Remarks
		Cast iron	Cast steel						
1	Gatevalve flanged end.	Cast iron		7 - 240	Ø 0.5" - 12"		450	90	
2	Globe Valve flanged end	=		7 - 240	0.5" - 12"		900	180	
3	Flanges		C. Steel	0.906-36.24	0.5" - 12"		6 500	130	
4	Elbows		=	0.072-35.96	0.5" - 12"		5 650	2.5	
5	Reducers		=	0.181-6.79	1" - 8"		625	2.5	
6	Tees (T)		=	0.28 -11.32	1" - 6"		375	2.5	
7	Straight		=	0.28 -11.32	1" - 6"		375	2.5	
8	Caps		=	0.11 -2.91	1" - 6"		200	1.5	
9	Gate valve flanged end		=	7 - 240	0.5" - 12"		450	90	
10	Globe valve flanged end		=	7 - 240	0.5" - 12"		450	90	
	Sub. TOTAL							432 270	T Cast Steel T Cast Iron

GENERAL ESTABLISHMENT OF PETROL Refinery

Annual Consumption for :

Of The Steel and cast iron castings

No.	Name of piece	Material		Appro. Weight(KG)	Appro. Dimensions(MM)	Unit.Price in S.P. or foreign cur.	Quantity (PES)	Annual reqTon	Remarks
		Cast iron	Cast steel						
11	Others								
	- Impellers		C.Steel	1-25			500	5	
	- Diffusers		=	5-100			50	2.5	
	- Casing of pumps		=	50-250			150	20.5	
	- Gear Boxes		=	40-200			10	1	
	- Linners		=	10-60			150	6	
	- Blades of air fan.		=	1-50			100	4	
	Total							471 T	Cast steel
								270 T	Cast Iron

Table (14)

Annual Consumption for : SUGAR ESTABLISHMENT

Of The Steel and cast iron castings

No.	Name of piece	Material		Appro. Weight(KG)	Appro. Dimensions(MM)	Unit.Price in S.P. or foreign cur.	Quantity (PES)	Annual req.Ton	Remarks
		Cast iron	Cast steel						
1	Gears		C. Steel	400	2 000	150 per/ kg	50	20	
2	Oil Extraction Machine Parts		"	500	2 000	150 Per/ kg	50	25	
3	Cupling	Gray Iron		10	100	120 Per/ kg	200	2	
4	(V) Belt Pully	" "		25	300	120 " "	100	2.5	
5	Various Pieces	" "		10		120 " "	500	5	
6	Air Compressor Parts	" "		5 - 25	1 000	120 " "	60	1	
7	Vacuam Pump Cylinder	" "		300	650	120 " "	15	1.5	
8	Wheels	" "		70	700	120 " "	100	7	
9	Filter,s Head	" "		600	1 000		10	6	
10	Bearing Bodies	" "		50		120 " "	100	5	
	TOTAL							45 Ton 33 "	Steel Cast Iron

Table (15)

Annual Consumption for : Transport Establishment

Of The Steel and cast iron castings

No.	Name of piece	Material		Appro. Weight (KG)	Appro. Dimensions (MM)	Unit.Price in S.P. or foreign cur.	Quantity (PES)	Annual req.Qty Ton.	Remarks
		Cast iron	Cast steel						
1	Brake drum for rear wheel	x		50	Ø 470		1500	90	
2	Brake drum for front wheel.	x		38	Ø 450		1000	38	
3	Fly wheel	x		35	Ø 485		1000	35	
4	Clutch pressing plate	x		17	Ø 390		1000	17	
5	Cylinder	x		5	Ø 135		1200	6	
6	Flange	x		1-5	Ø150-300		1000	4	
7	Gears	-	x	0.5 - 20	Ø 50-300		1500	15	
8	Sprocket wheel		x	10 - 50	Ø 100-400		500	15	
9	Mescillaneous								
	Total							190 T	Cast Steel
								30 T	Cast Iron.

OUT-LINES FOR DESIGNINY

PILOT FOUNDRY LABORATORIES

/Specification of Equipment

'Devices and Accessories/

Classification of foundry-laboratories according to their function

Designation	Type of foundry, capacity, type of cast material and other data	Sand Testing	Metallography	Mechanical Properties	Melting	Wet Chemical	Samples Preparation
F1	Small foundry producing gray iron castings and non-ferrous metals up to 1000 m.t/year	S1	x	x	x	x	x
F2	Medium-size foundry producing gray, and malleable iron or steel castings up to 3000 m.t/year	S2	G1	x	x	x	x
F3	Large foundry producing ferrous metal castings, more than 3000 m.t/year	S2	G2	T	M	x	x
PR	Pilot regional foundry with complete testing facilities to assist other foundries in solving problems of technology design quality, materials and training programmes	S3	G3	T	M	C	SP

FOUNDRY LABORATORIES

CAPITAL AND AREA REQUIREMENTS

Type of laboratory	Designation	Number of rooms	Area of laboratory /sm/	Estimated prices of equipment in US Dollars
Sand Testing	S1	1	27	20.000
	S2	1	27	40.000
	S3	2	40	77.000
Metallography	G1	3	27	40.000
	G2	4	40	60.000
	G3	3	45	60.000
Mechanical Properties	T	1	36	75.000
Melting	M	1	24	60.000
Wet Chemical	C	2	54	45.000
Samples Preparation	SP	1	48	85.000

LABORATORY	Sand Testing /in plant/	Design.: S1

Number of feed-points:			Area: 27 sm
Lighting	Power	Water	
4	1	1	

Efficiency and other characteristics:

8 tests daily, or more if required.
Hardness testing of casting and sample preparation

Item	Name of apparatus, short characteristic and other data	Quantity
1	2	3
S1.1	Infra-Red Rapid Dryer; Drying of substances by infrared radiation 2x250 VA; 50/60 cycles; timer 15 min	1
S1.2.	Test Specimen Weight Scale. Ranges: 0-210 g; 0-2 kg; Sensitivity: 0,2 g	1
S1.3	Sand Rammer; Preparation of test specimen; Concrete foundation required	1
S1.4	Accessories to Sand Rammer	
S1.5	Permeability Meter; Determination of the gas permeability;	1
S1.6	Accessories to Permeability Meter	
S1.7	Universal Strength Machine; Determination compressive strength up to approx. 30 N/scm sher strength up to approx. 25 N/scm	1
S1.8	Accessories to Universal Strength Machine	
S1.9	Mould Strength Tester. Determination of compression strength up to 35 N/scm in green moulds and on test specimen	1
S1.10	Green Hardness Tester. Surface hardness of compacted moulds and cores	1
S1.11	Core Hardness Tester. Determination of hardness of dried cores	1
S1.12	Table	1
S1.13	Swivel chair. Crack resistant, plastic seat	4
S1.14	Sink for hot and cold water	1
SP.5	Bench drilling machine	1
SP.8	Shop grinding machine	1
T.6	Hardness tester acc. to Brinell meth.	1
S1.15	Work table	3
S1.16	Small tools [illegible]	

LABORATORY	Sand Testing		Design.: S2
Number of feed-points:			Area: 27 sm
Lighting	Power	Water	
4	2	3	

Efficiency and other characteristics:

up to 18 tests daily, or more if required

Item	Name of apparatus, short characteristic and other data	Quantity
1	2	3
	Equipment designed for laboratory S1: S1.1 up to S1.11; S1.15; S1.16	
S2.1	Core Sand Mixer; Capacity 1-2 kg, Preparation of test mixes of oil, resin and silicate-bonded sands; capacity 1-2 kg	1
S2.2	Core Drying Oven, Capacity: approx. 100 litres; Temperature range up to 250°C	1
S2.3	Laboratory Mixer; Capacity 5-10 kg, Preparation of test mixes of clay-bonded sands	1
S2.4	Cupboard	1
S2.5	Sink for hot and cold water	1
S2.6	Continuous Clay Washer. Automatic and continuos removal of the fines / < 20 µm/	1
S27.	Agigator. Determination of fines	1
S2.3	Laboratory Sifter. Sieve analyses	1
S2.9	Swivel chair. Crack resistant, plastic seat	4
S2.10	Table	1

LABORATORY	Sand Testing	Design.: S3
Number of feed-points:		Area: 40 sm

Lighting	Power	Water	N_2	CO_2	Acetyl	Allgas
8	3	5	1	1	1	1

Efficiency and other characteristics:
more than 30 tests daily, mediatory tests, and scientific research

Item	Name of apparatus, short characteristic and other data	Quantity
1	2	3
	Equipment designed for laboratory S2: S1.1 up to S1.16 and S2.1, S2.2 - S2-5, S2.6, S2.7, S2.8	
S3.1	Drying Cabinet. Drying of sand and binder samples. Capacity: approx. 34 l Temperature range: 40-240°C	1
S3.2	Fume Hood. 1200x800x2400. Equipment fittings: 1xWater; 1xAllgas; 2x220 V	1
S3.3	CO_2-Gassing Controller. The carbon dioxide gassing of test specimen under adjustable conditions	1
S3.4	Sintering Furnace. Determination of sinter and melting points. Loss on ignition, incineration	1
S3.5	Underbench cupboards for worktables and table	2
S3.6	Stereo Microscope to determine the grain form and surface of the sand. Magnification 15 and 30 times	1
S3.7	Table	1

LABORATORY	Metallography		Design.: G1
Number of feed-points:			Area: 27 sm
Lighting	Power	Water	
8	2	2	

Efficiency and other characteristics:
Preparation and analysis of metallographic samples, acc. to the quality control program /e.g. 2 per hour/

Item	Name of apparatus, short characteristic and other data	Quantity
1	2	3
G1.1	Microscope stand, rotatable mechanical stage, binocular viewing tube. Magnification up to 1000x	1
G1.2	Stereoscopic microscope. Magnification up to 30x	1
G1.3	Equipment for embedding of samples /cold method/	1
G1.4	Desk	2
G1.5	Two wheels for manual grinding and polishing of samples	[illegible]
G1.6	Work-stand for etching	1
G1.7	Sheet-steel cabinet	1
T.3	Hardness tester, acc. to Brinell, Vickers or Rockwell. Test load: up to 3000 kg	1
SP.5	Bench drilling machine	1
SP.8	Shop grinding machine	1
G1.8	Work bench	[illegible]
SP.11	Cut-off bandsawing machine	1
G1.9	Swivel chair. Crack resistant, plastic seat	4
G1.10	Small tools, equipment, accessories	set
SP.10	Mobile Crack Testing Detector. Cracks detection based on magnetic powder process [optional]	1
G1.11	Sink for hot and cold water	1

LABORATORY	Metallography		Design.:	G2
Number of feed - points:			Area:	40 m
Lighting	Power	Water	Allgas	
12	2	3	2	

Efficiency and other characteristics:
Preparation and analysis of metallographic samples, acc. to the quality control program /e.g. 5-6 per hour/. Scientific research

Item	Name of apparatus, short characteristic and other data	Quantity
1	2	3
	Equipment designed for laboratory G1: G1.1 up to G1.11 and T.3, SP.5; SP.8, SP.10, SP.11	
G2.1	Dark room with complete equipment for photographic documentation	set
G2.2	Equipment for automatic preparation of metallographic samples	1
G2.3	Electrolyte grinding of metallographic samples	1

LABORATORY	Metallography			Design.: G3
Number of feed-points:				Area: 45 sm
Lighting	Power	Water	Allgas	
12	2	3	2	

Efficiency and other characteristics:
Preparation and analysis of metallographic samples acc. to the quality control program /e.g. up to 12 per hour/
Scientific research

Item	Name of apparatus, short characteristic and other data	Quantity
1	2	3
	Equipment designed for laboratory G2: G1.1 - G1.7 and G1.9; G1.11, G2.1- G2.3	
G3.1	Great inverse microscope for examination metallographic specimens equipped with basic photographic equipment and microscope camera for size 24x36 cm	1
G3.2	Sample Storage	1
G3.3	Table	1

Number of feed-points:				Area: 36 sm
Lighting	Power	Water		
12	2	3		

Efficiency and other characteristics:
Routine and standard tests acc. to the quality control program, and as mediatory tests. Scientific research X-ray investigation and ultrasonic

Item	Name of apparatus, short characteristic and other data	Quantity
1	2	3
T.1	Universal testing machine. Determination of tensile compression and bending strengths. Max. test load up to 40 t. Accessories equipment	1
T.2	Pendelum impact testing machine. Max. striking energy of 150 Nm	1
T.3	Hardness tester, methods: Brinell, Vickers or Rockwell. Test load: up to 3000 kg	1
T.4	Ultrasonic flaw detector. Testing of metals, weld inspection and thickness measurement. Special ultrasonic proves and other equipment	1
T.5	Underbench cupboards for worktables and table	1
T.6	Hardness tester /Brinell/	1
T.7	Portable X-ray apparatus. Tubehead, Voltage range 35-200 kV. Specified for "in-plant" installation	1
T.8	Small tools, equipment, accesories	set

Note:

Maintenance Section of Laboratory Instruments

including electronic, machanical, electrical, calibration and other units recommended to be placed on the second floor.

LABORATORY	Sample Preparation	Design.: SP
Number of feed-points:		Area: 48sm

Lighting	Power	Water	
12	6	3	

Efficiency and other characteristics:
Preparation tests for metallography, mechanical properties investigation and for wet chem. laboratory. Non-destructive testings /magnetic/

Item	Name of apparatus, short characteristic and other data	Quantity
1	2	3
SP.1	Heavy-duty precision lathe, for the machining of test samples; Height of centers - 145 mm; Distance between centers - 750 mm	1
SP.2	Cut-off grinder, for cutting off metallic samples	1
SP.3	Mechanical high-speed shaping machine	1
SP.4	Work bench	1
SP.5	Bench drilling machine	1
SP.6	Toolmaker's flat	1
SP.7	Tool room	1
SP.8	Shop grinding machine	1
SP.9	Work-stand for penetrant fluid test	1
SP.10	Mobile Crack Testing Detector. Cracks detection based on the magnetic powder process [optional]	1
SP.11	Cut-off band sawing machine	1
SP.12	Sink for hot and cold water	1

LABORATORY	Metallography			Design.: G3
Number of feed-points:				Area: 45 sm
Lighting	Power	Water	Allgas	
12	2	3	2	

Efficiency and other characteristics:
Preparation and analysis of metallographic samples acc. to the quality control program /e.g. up to 12 per hour/
Scientific research

Item	Name of apparatus, short characteristic and other data	Quantity
1	2	3
	Equipment designed for laboratory G2: G1.1 - G1.7 and G1.9; G1.11, G2.1- G2.3	
G3.1	Great inverse microscope for examination metallographic specimens equipped with basic p[illegible]graphic equipment and microscope camera for 24x36 cm	1
G3.2	Sample Storage	1
G3.3	Table	1

LABORATORY	Mechanical Properties	Design.: T

Number of feed-points:	Area: 36 sm

Lighting	Power	Water	
12	2	3	

Efficiency and other characteristics:
Routine and standard tests acc. to the quality control program, and as mediatory tests. Scientific research X-ray investigation and ultrasonic

Item	Name of apparatus, short characteristic and other data	Quantity
1	2	3
T.1	Universal testing machine. Determination of tensile compression and bending strengths. Max. test load up to 40 t. Accessories equipment	1
T.2	Pendelum impact testing machine. Max. striking energy of 150 Nm	1
T.3	Hardness tester, methods: Brinell, Vickers or Rockwell. Test load: up to 3000 kg	1
T.4	Ultrasonic flaw detector. Testing of metals, weld inspection and thickness measurement. Special ultrasonic proves and other equipment	1
T.5	Underbench cupboards for worktables and table	1
T.6	Hardness tester /Brinell/	1
T.7	Portable X-ray apparatus. Tubehead, Voltage range 35-200 kV. Specified for "in-plant" instalation	1
T.8	Small tools, equipment, accesories	set

Note:

Maintenance Section of Laboratory Instruments

including electronic, mechanical, electrical, calibration and other units recommended to be placed on the second floor.

LABORATORY	Wet Chemical	Design.: C
Number of feed-points:		Area: 54 sm

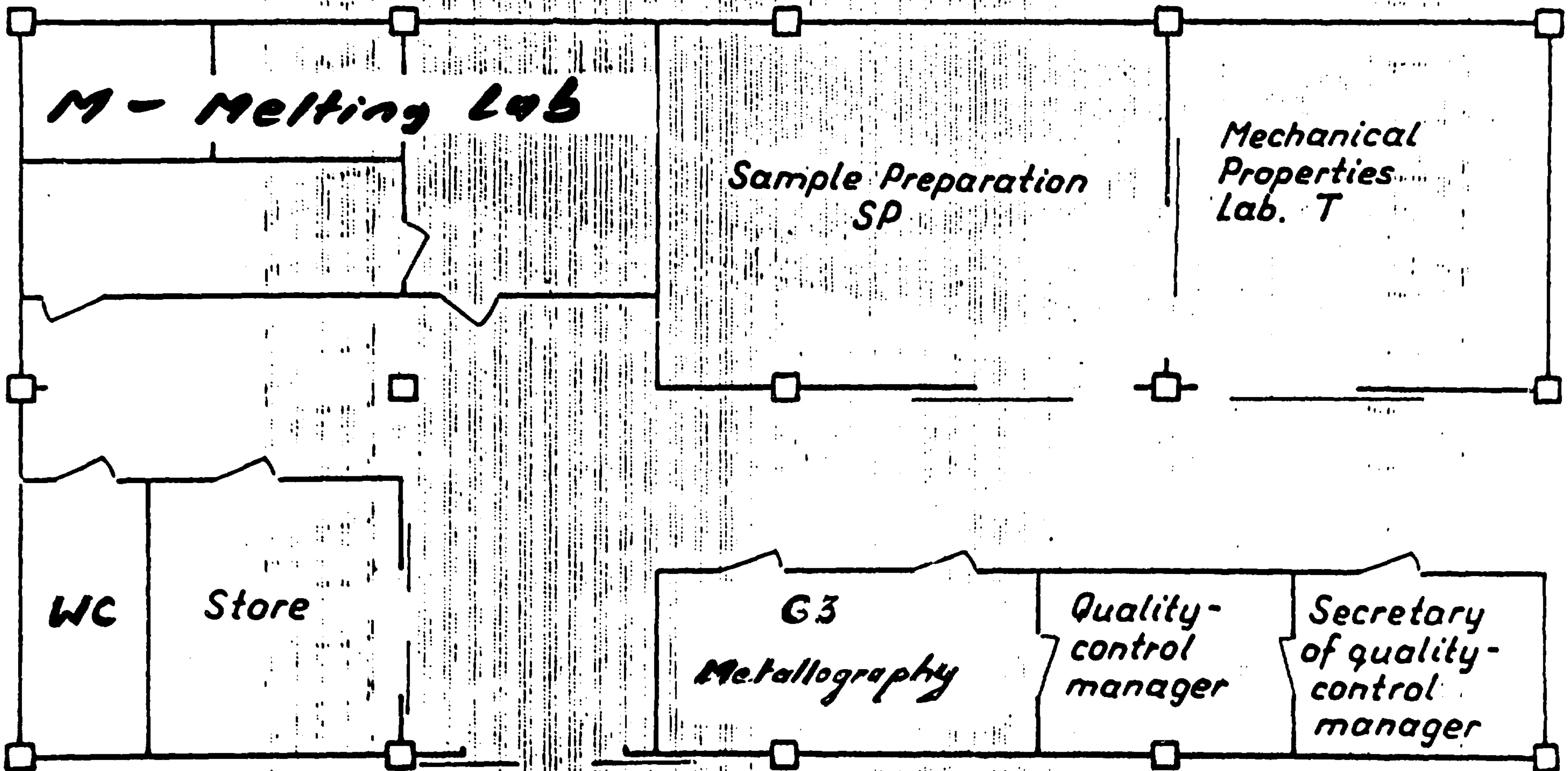
Lighting	Power	Water	
12	2	5	

Efficiency and other characteristics:
Chemical tests of S, P, Si, alloy elements, 5-6 specimen per hour; Mediatory tests

Item	Name of apparatus, short characteristic and other data	Quantity
1	2	3
C.1	Automatic water distillation apparatus Output 7 l/h	1
C.2	Fume Hood	2
C.3	Work bench	2
C.4	Cupboards for acids and lyes	3
C.5	Sheet-steel cabinet	2
C.6	Desk	2
C.7	Weighing place	1
C.8	Precission balance. Scale division 0,01 g	1
C.9	Apparatus for volumetric carbon analysis and titrimetric sulphur acalysis in iron, steel and other metals by combustion	1
C.10	General laboratory appliances of glass, porcelain and metals	-
	Optional /alternative Spectrometric Laboratory	

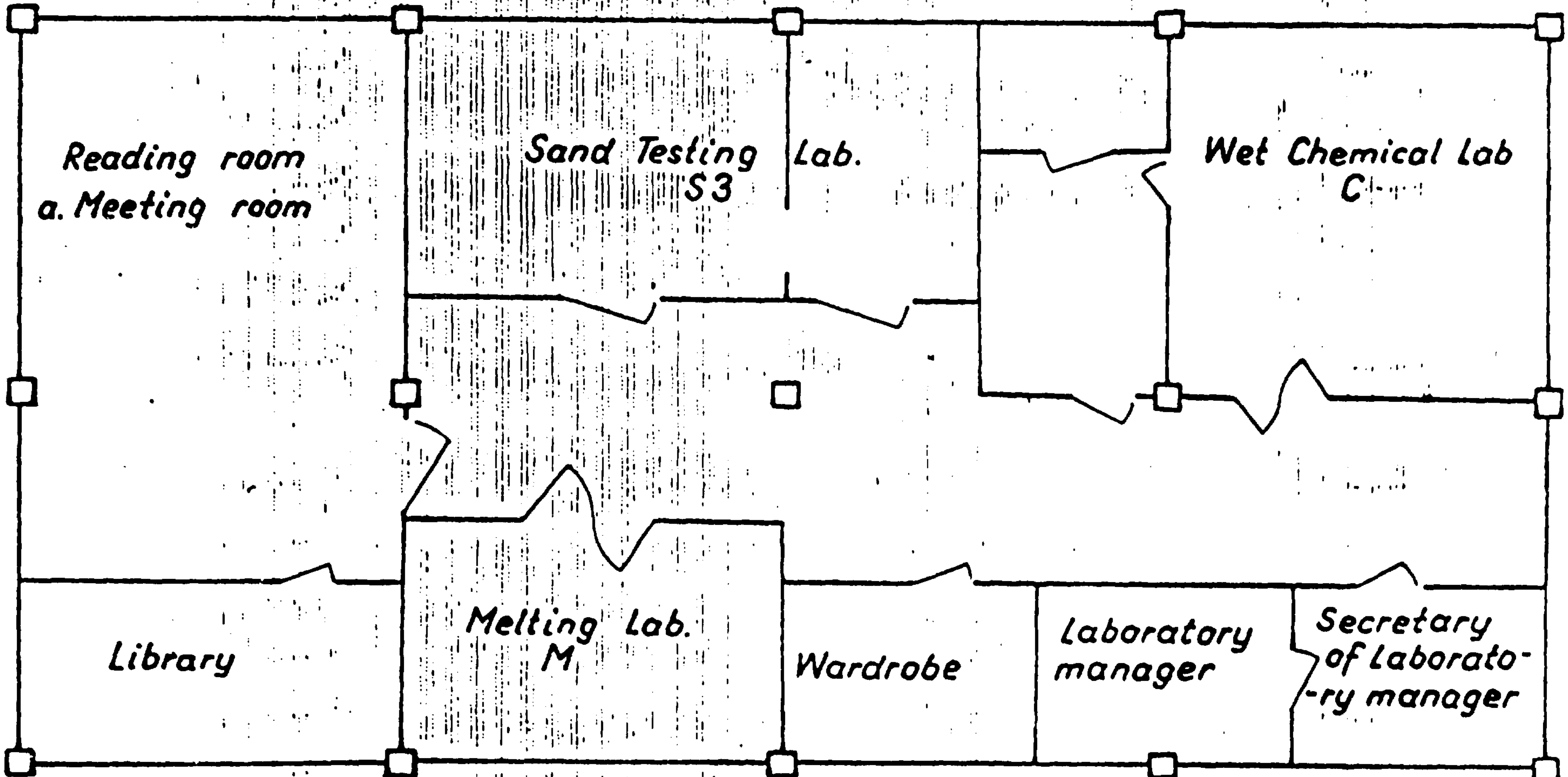
CONCEPTUAL LAY-OUTS OF PILOT LABORATORY

/Laboratory Sections/

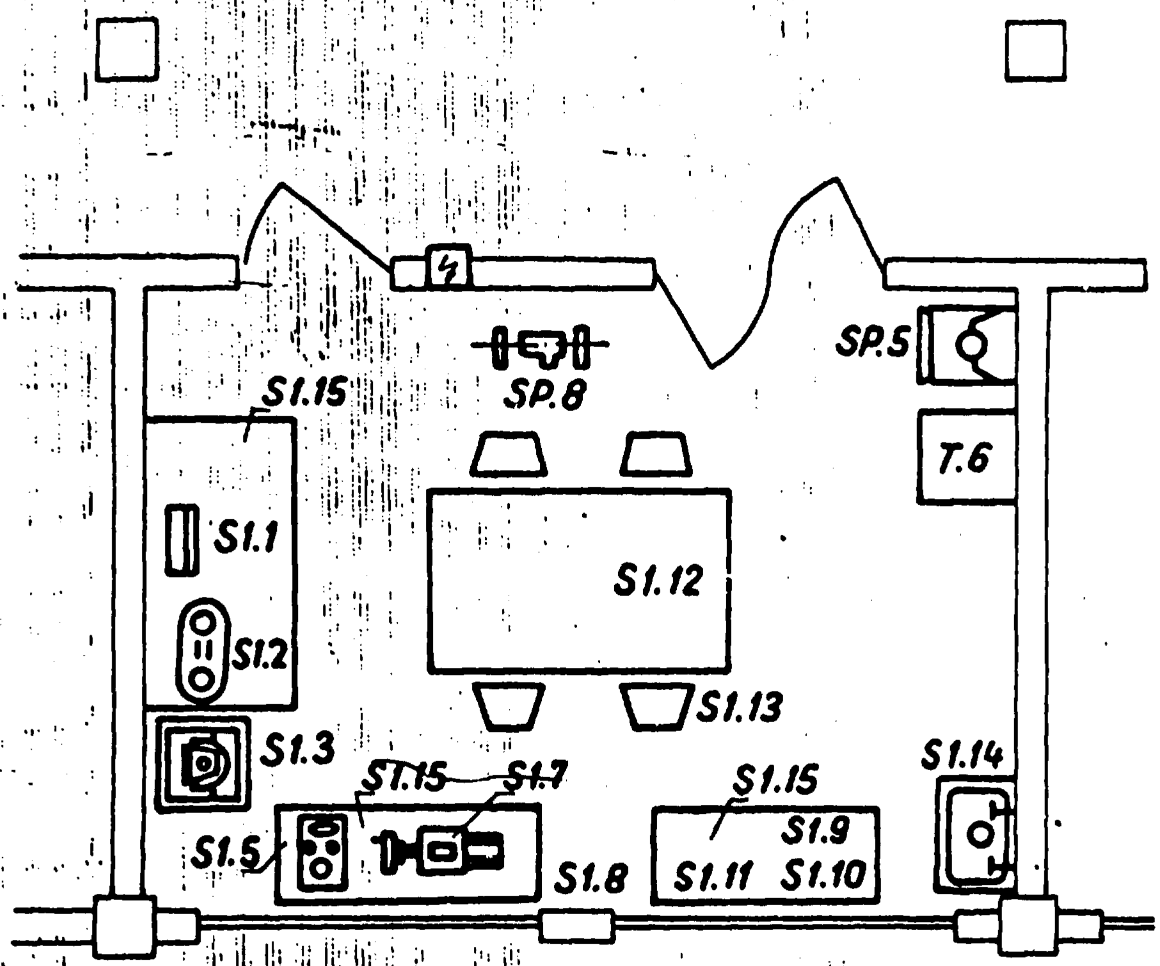


Layout of laboratory in pilot [regional] foundry (ground floor)

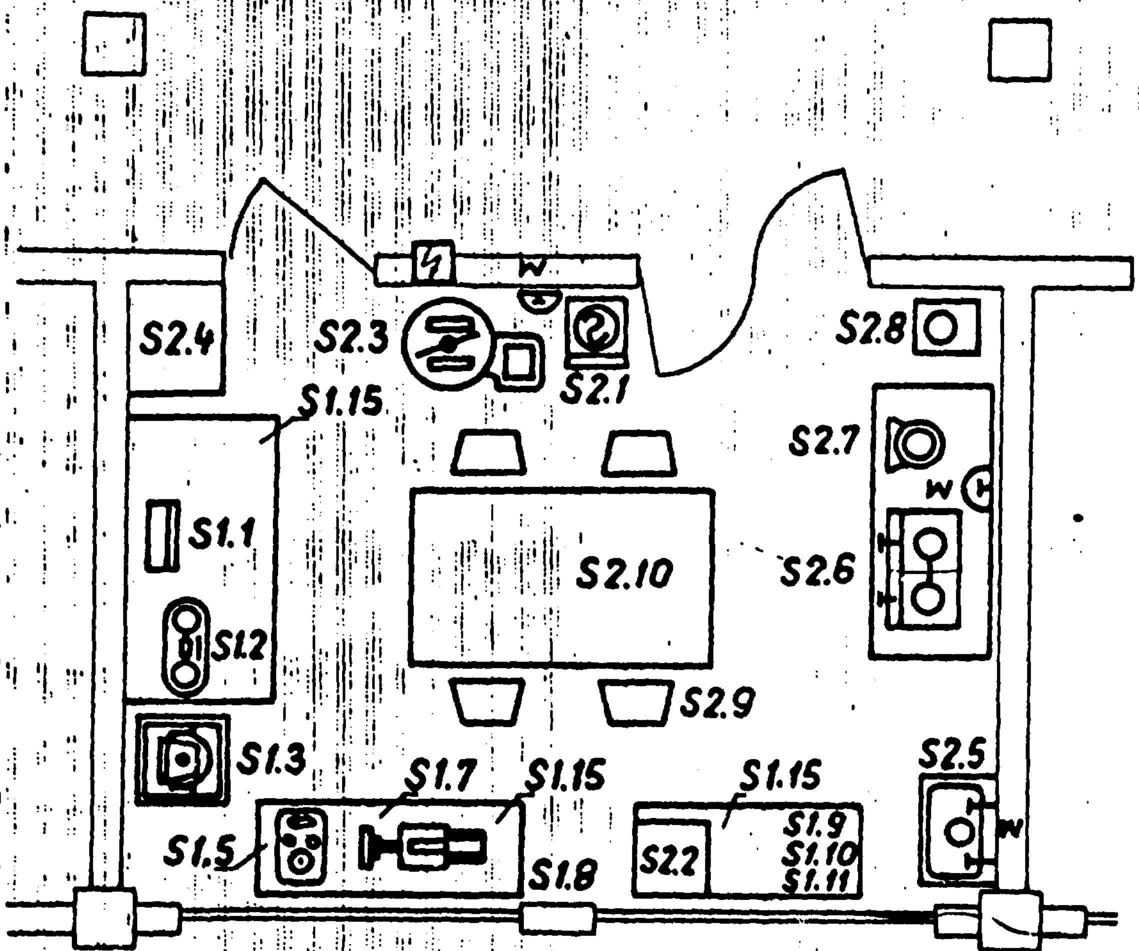
Scale 1:100



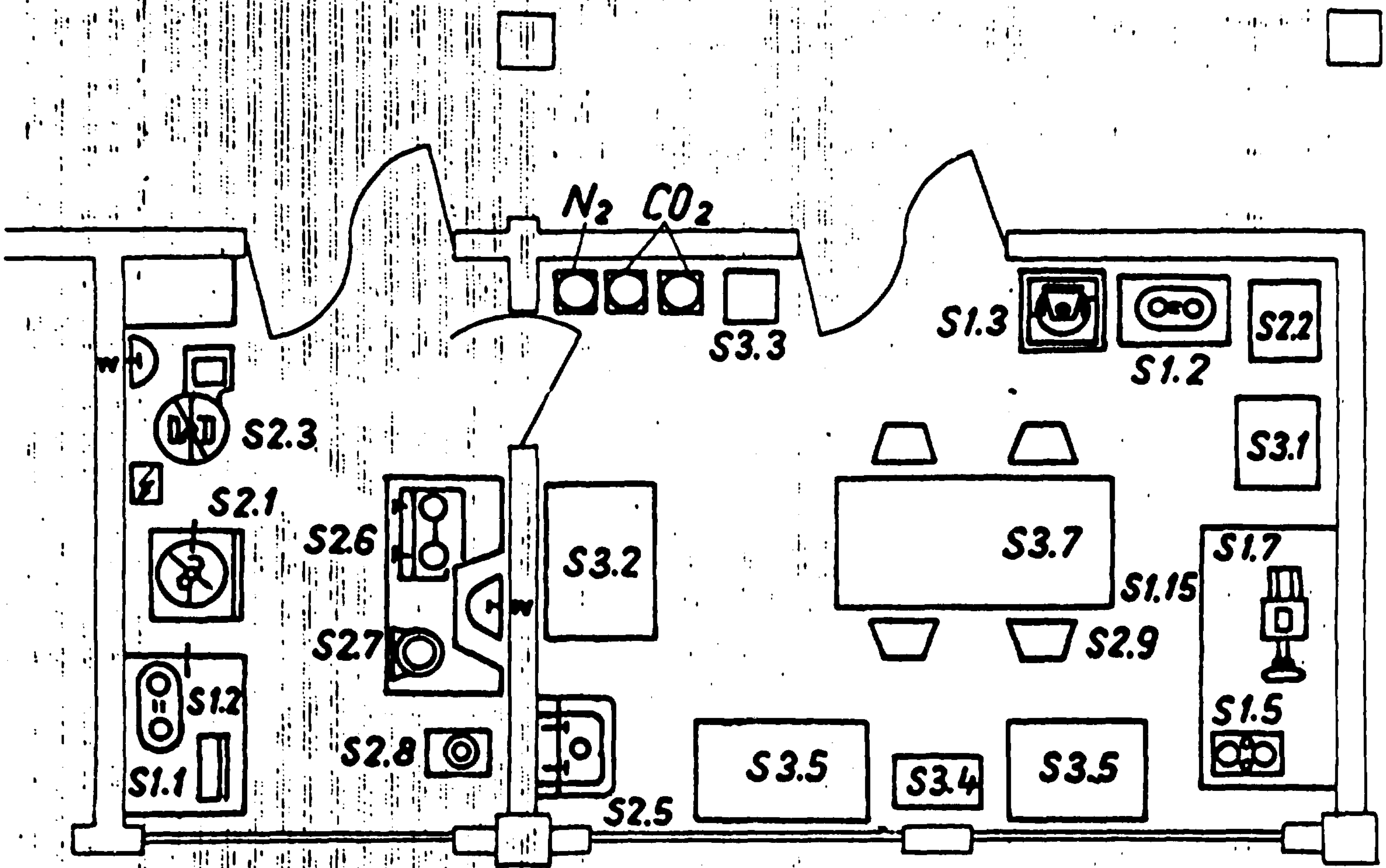
Layout of laboratory in pilot regional foundry (first floor)
Scale 1:100



layout of sand testing laboratory (S1)
Scale 1:50

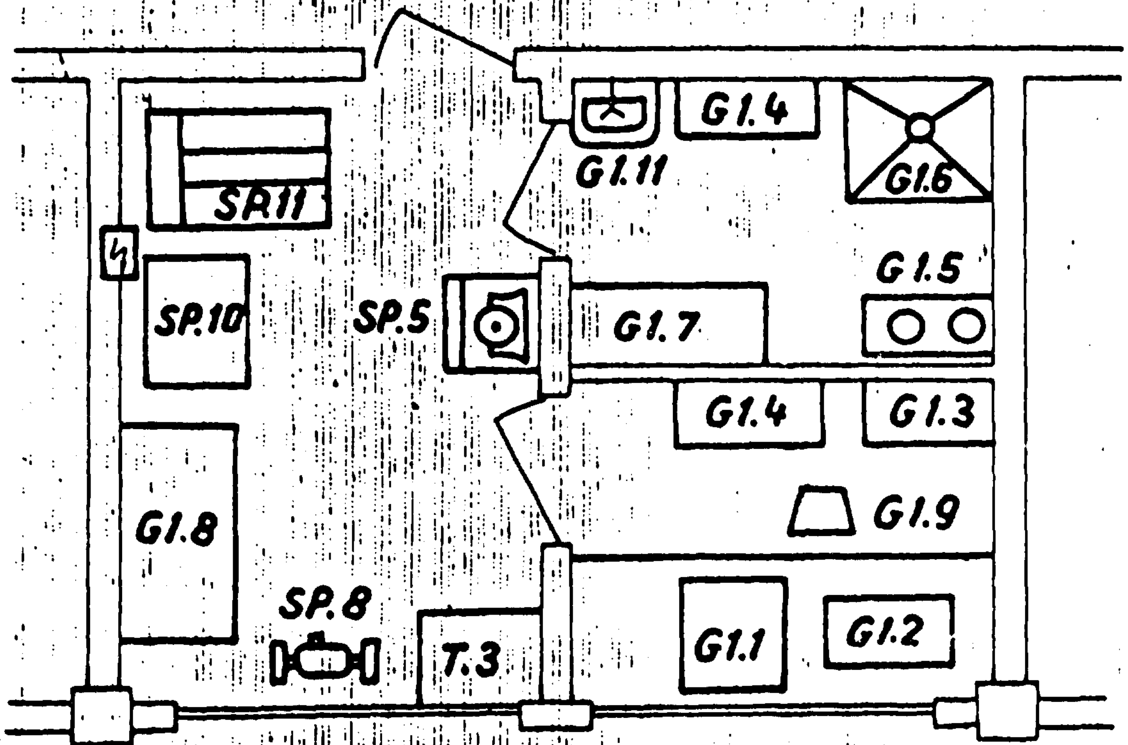


Layout of sand testing laboratory (S2)
Scale 1:50



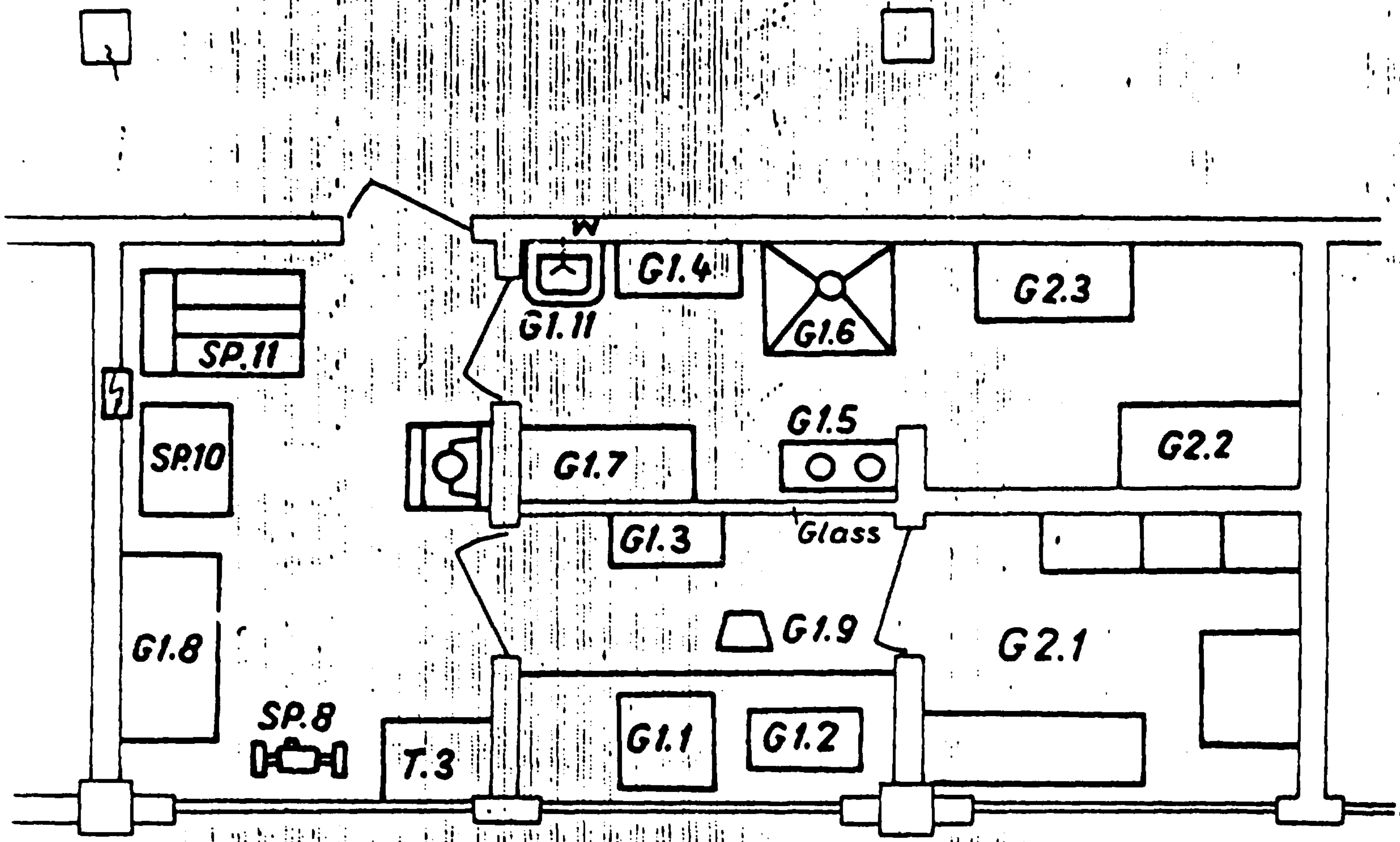
Layout of sand testing laboratory (S3)

Scale 1:50

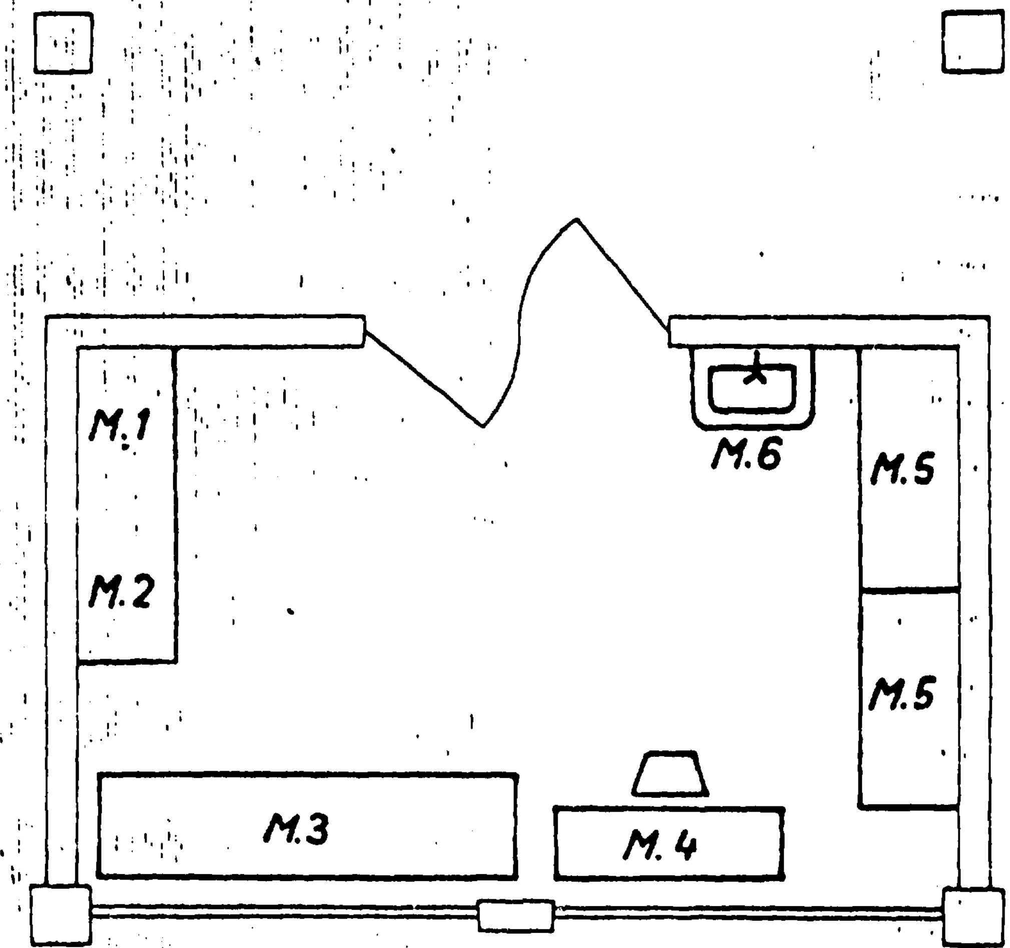


Layout of metallography laboratory (G1)

Scale 1:50



Layout of metallography laboratory (G2)
Scale 1:50



Layout of melting laboratory (M)

Scale 1:50

WP/A\SYR89241\SYRPDRV2 AB/rg/11November 1991

D R A F T

UNITED NATIONS DEVELOPMENT PROGRAMME

Project of the Government of Syria

PROJECT DOCUMENT

Project Number:	DP/SYR/92/xxx
Project Title:	Assistance in Establishing a Pilot Demonstration Foundry.
Project Site:	Damascus
ACC/UNDP Sector and Subsector:	0510 Industrial Development Support Services
Government Implementing Agency:	Scientific Studies Research Centre, Damascus
Executing Agency:	United Nations Industrial Development Organization (UNIDO)
Estimated Starting Date:	1 May 1992
Government Inputs	SYP 350,000,000
UNDP Inputs:	US $ ....
Government Cost Sharing Inputs:	US $ ....
Total Convertible Inuts:	US $ 1,975,000

Brief Description Studies made by the UNIDO Regional and Country Studies Branch and by the UNIDO Metallurgical Industries Branch clearly demonstrate that the maintenance of Syrian Industry suffers greatly because of a cronic lack of spare parts. This project is designed to assist in promoting the manufacture of spare parts and of parts for machinery, equipment and agriculture by establishing and initiating the operation of a Pilot Demonstration Foundry (PDF) with integrated laboratory,manufacturing a demonstration production of 1,000 - 1,500 tonnes per annum of advanced cast parts, together with technical advisory services for Industry to prepare for Industry the metallurgical specifications for spare parts. The PDF will:

i) Develop and prepare casting designs and production methods for industry and introduce correct operational procedures for the use of local raw materials

ii) conduct 'on-the-job' training of management, technical staff and skilled workers, in an efficient environment operating to internationally accepted standards.

iii) undertake development work to up-grade foundry techniques and introduce the production of increasingly more advanced castings and cast alloys including prototype cast spare parts, and to transfer this technology to Industry by demonstration and training in the operational environment.

iv) from within the operational environment, transfer new technologies to other industries and provide advisory services on materials specifications and quality requirements.

A. CONTEXT

A.1. Background

UNIDO has prepared studies concerned with the status of Industry at a national level and with the situation existing in the maintenance of plant and equipment in Syria. One of the common, negative factors which emerges strongly from these studies is that the industry is seriously affected by a severe shortage of spare parts and by the ablity to prepare parts af adequate quality. A project, proposed to introduce 'Computerized, Managed Maintenance' into industry will be seriously compromised if the supply of spares is not greatly improved. and a further project, proposed to establish an Engineering Design Centre will not be relevant to the Engineering Industries if the correct metallurgical specifications cannot be prepared and if the Foundry Industry is not able to produce and supply castings of the correct specifications to the Engineering Industry.

In synthesis, without a healthy Foundry Industry, the Industry Sector cannot operate efficiently.

The study made for this project by a consultant team, assisted by the SSRC under a UNIDO preparatory assistance programme shows that there exists in Syria an **unsatisfied market of some 50,000 tons per annum of castings**, including spare parts, parts for agricultural machinery, agricultural hand tools and other for industrial equipment. It is thus essential to accelerate the development of the Syrian foundry Industry by the most direct action possible.

The seriousness of the problem is accentuated by the picture which emerges from the information collected, which is that the industrial sector in Syria is comparatively well developed and contributing about 30% of the GPN. The importance of the Industry to the economy is thus clear.

The Industry is composed principally of the following significant industries (industrial branches):

- chemical incl. fertilizer manufacture
- petrochemical
- cement
- textile
- food processing incl. sugar factories
- geological/mine and mineral processing
- building, industrial and general construction incl. roads and bridges construction
- transport equipment
- engineering/metal processing

- steel industry.

The concentration of important production potential is found in Damascus, Aleppo, Latakia, Homs and their suburbs, where cement, food processing, fertilizer, petrochemical, building construction companies are operating apart from a large number of small-scale workshops of various profiles.

The existing status of engineering and allied metal working and steel processing industries reveals the following important findings, namely:

- the input materials required are mostly imported from abroad; (a.o. castings, forgings, metal sheets, steel bars);

- the country has basic metal transformation facilities, i.e. melting, rolling, casting, forging, etc. which are not developed to the extent adequate to the present state and future development plans of the country's economy;

- Heat treatment facilities exist in several workshops, however, their use is rather limited by both demand and by their reltively limited techical level.

- the system of quality control applied by most of the workshops as well as the product quality require to be improved;

- there is a strong tendency, suported by most of the production technical staff to upgrade manufacturing technology;

- the growing demand for castings is mostly met by the import of finished parts.

A.2. Host Country Strategy

In conformity with the objectives and strategies of the National Development Plan, the Government has decided to give high priority to technical co-operation in the fields of agriculture, industry, energy and mining. Several mission surveys and sectoral studies were conducted to identify the specific technical assistance needs of those sectors.

These studies have been instrumental in the identification of areas in which technical co-operation is urgently required in furtherance of the major objectives of the Plan. As a result, the Government has described priority requirements for technical co-operation as:

(a) Introducing new technologies in the various sectors of the economy;

(b) building up skilled labour, particularly at the intermediate/subprofessional level through education and training;

(c) Improvement of industrial production, amongst other, through acquisition of advanced technologies from abroad.

A.3. Prior assistance

A preparatory assistance project, to study the establishment of a Pilot Demonstration Foundry has been implemented in 1991.

The purpose of the project financed and executed by UNIDO was:

- to prepare market analysis for castings to be manufactured by the projected foundry;
- to elaborate a detailed work programme for the establishment of a Foundry with an integrated Pilot Laboratory;
- to prepare financial analysis of the foundry operation and to indicate the volume of future financial inputs which may be required;
- to elaborate the project document on establishment of a Pilot Demonstration Foundry (PDF) with integrated laboratory.

A.4. Institutional Framework for the sub-sector

A.4.1. Institutions responsible for the development of engineering and metal industries

A supreme authority is assigned to the Council of Ministers and Ministry of Finance.

On a lower, operational level, the offices of respective ministers and industrial corporations are directly responsible for development of the administrated enterprises and industrial establishments. SSRC provides technical research and development support.

A.4.2. Institutions responsible for manpower development

Besides the well developed network of primary and secondary schools and the University in Damascus, all under the administration of the Ministry of Education, there is the Higher Institute of Applied Science and Technology in Damascus. The Institute has been functioning since 1983 based on a very comprehensive educational programme applied for an elite group of engineers trained in scientific research.

B. PROJECT JUSTIFICATION

B.1. Problem to be addressed: the present situation

The overall problem is the inability of the Foundry Industry so supply sufficient castings of adequate quality to the Industry sector. These castings may be for spare parts, for parts for agricultural equipment tools, and other parts for machinery and equipment. The shortage of castings and the inability of the Foundry Industry to resond to the requirements of the Engineering Industry and the Equipment and Machinery manufacturers is a serious restriction on the operation and development of the Industry Sector.

B.1.1 Preparation of Specifications:

The preparation of specifications for metal spare parta and other tools and parts is not commonly done in Syria. Thus it is impossible to produce quality parts, but 'quality' can only be measured against a 'specification; which consists of the complete technical description of the item. An item which complies with the specification is clearly of adequate 'quality' thus in order to produce a metal spare part, the indispensable first step is to specify what is to be produced. This process begins with materials selection, The preparations for the manufacture of a metal part begin with the design and the specification of the properties required of the part,and thus of the material. This leads to the requirement for an alloy which has the required combination of properties, for example one or more of:

- strength/hardness,
- Heat resistance,
- Low temperature properties,
- corrosion resistance in given environment(s),
- wear resistance,
- impact strength.

As all these properties are not obtained in one alloy, a trade-off must be made whilst maximising the most critical properties. The selection of the most adequate alloy thus requires considerable experience and knowledge in order to obtain the best possible results.

The resulting specifications must contain:

Metallurgical:

- Chemical composition of the alloy to be used.
- Metallographic structure specification.
- Mechanical properties of the alloy as used, with a description of the heat treatment or other processes to be used to obtain these properties.
- Specification of other treatments, such as electroplating, or other coating processes with process and product description.
- Manufacturing processes to be used, together with process specifications where relevant.

- Quality control/assurance procedures.

Mechanical:

- Engineering drawing with dimensional tolerances and where relevant, surface finish specifications,
- Quality control/assurance procedures.

It is clear from the above that the first task to be performed in the procedures leading to the production of a metal part, concern the preparation of specifications

B.1.2.1 <u>Importance of the Foundry</u>

Castings are an indispensible input to engineering and allied metal working industries, agricultural machinery and transport equipment industries, communication, power, construction, health care, education and all related sectors of economy.

B.1.2.2 Advantages of the casting process

The following are, among many others, the major advantages of the casting process:

- low cost; castings are usually found to be the cheapest method of metal shaping;

- dimensional accuracy: castings can be made, depending on dimensional tolerances, e.g. as close as 0.1 mm and surface finish from 5 to 50 microns by choosing appropriate moulding and casting process.

B.1.2.3. Existing foundry facilities in Syria

Most of the operations are carried out manually using obsolete techniques and tools.

Process design activities directed towards upgrading the foundry operations are being rarely undertaken.

The lack of sufficient qualified technical cadres in the foundry industry along with limited and restricted laboratory facilities make it impossible to implement any R+D programme at present.

B.1.2.4. Major aspects of castings production in Syria

The situation concerning the status of the Syrian foundry industry can be summarized as follows:

(i) acute deficit of cast spares and cast elements estimated in the country scale - at over 50.000 tonnes/year and almost entirely covered by the growing import;

(ii) low and limited production capacity of the existing foundry workshops;

(iii) inadequate and inefficient work-methods and processes employed by most of the foundries;

(iv) low degree of mechanization of foundry operations;

(v) lack of automation and appropriate quality control procedures normally applied;

(vi) absence of training center(s) and regular programmes for up-grading the skill of foundry technical and skilled personnel;

(vii) insufficient R and D facilities, normally required to develop and implement the design of the prototype castings and to transfer operational technologies to the Industry.

B.2. Development problems

The development problems have been identifi^d as follows:

(i) at country level

A rapidly growing demand for cast spare parts caused by a diversifying scope of maintenance (machine repair) services and the import of new machines and equipment.

(ii) at the sectoral level

An urgent need to:

- Introduce and diffuse the methodology fopr the proeparation of metallurgical specifications for metal parts.
- upgrade the skill and qualifications of the manpower involved with the manufacture of castings.
- introduce adequate technologies, and provide advice concerning investment.

B.3. Expected situation of the end of the Project

B.3.1. **Specifictions Preparation:**
A unit will be operating within the PDF, utilising the laboratory facilities and bibliography to prepare full metallurgical specifications for metal parts fpr equipmaent and machinery and for spare parts. This service will be available for the use of the PDF, and for the public. Additonally the PDF will assist interested industries, groups of industries and institutions to establish similar units within their own organizations.

B.3.2. **Pilot Demonstration Foundry**

(i) a newly established and wholly mechanized foundry workshop of a considerable degree of automation designed to manufacture 1000 - 1500 tonnes of sophisticated castings per year;

(ii) increase of the present (1991) overall production of castings in the country scale by at least 10%;

(iii) provision of a modern laboratory, including a.o. spectrometer analytical section, integrated with the projected foundry, capable to undertake R and D and also to function as a diagnostic center for other foundries and metal-engineering industries;

(iv) use of the new modern foundry and laboratory facilities as a solid training basis for freshly graduated engineers and technicians, and also for supervisors and foremen, process designers, programmers of computerized systems incorporated into production lines, laboratory assistants and other foundry staff;

(v) well trained staff of the maintenance services capable to secure a continuous run of highly sophisticated electronic systems and efficient functioning of the installed mechanisms.

B.4. Target Beneficiaries

(i) How the results of the project will be utilized

Specifications Preparation.

- these services will be used, and these procedures be applied by all interested consumers of metal parts who require to obtain adequate quality parts for maintenance, and by extension, by insititutions which wish to provide services to industries which cannot establish the service for themselves.

Pilot Demonstration Foundry.

The sevices of the PDF will be used for:

- development and operational testing, demonstration and transfer of advanced casting methods;
- manufacture of prototype castings by means of advanced techniques will make it possible to diversify the maintenance services of heavy duty machinery to be imported in the future
- production of batch size high duty castings for the local industries. The product (which will not compete with local foundries) will be marketed at commercial rate;
- ad-hoc and regular services of the laboratory for other industries and workshops in testing of various raw materials and semi-finished products;
- continuous supply of various cast spare parts for the local maintenance (repair) service workshops and repair centers of agricultural machinery;
- the increased foundry production from the sub-sector will result in an import substitution estimated at about value USD 10.000.000 annually and considered as a target;
- provision of well trained foundry operators and laboratory assistants for other foundries, and for those to be established after 1995;

(ii) By whom the results of the project will be utilized

The results of the project will broadly benefit industry in and the economy in general through the increased availability of spare parts, leading to a consequent rise in the efficiency of the maintenance programmes of Industry.

B.5. Proposals of foundry projects

(identified by the Government for implementation)

Due to a high demand and consumption of alloy steel castings by the Syrian cement plants, the establishment of a production foundry (probably in Aleppo) is being considered by the Cement Industry Corporation.

B.6. Project strategy and implementation arrangements

B.6.1. Project strategy

The shortage of castings and spare parts must be aproached on several fronts simultaneously; one is to set up a system for preparing the specifications for the spare parts, the other is to promote the establishment of manufacturing plants, operated to correct procedures with adequate technical support and training facilities. The PDF will address these matters.

The foundry

This project will establish a Pilot Demonstration Foundry (PDF)in which processes are operated in a completely industrial envronment, this situation, designed to convince other foundry operators of the vialbility of the procedures used, and to facilitate the rapid transfer of technology to those other, commercial foundries and, most important will supply a training environment which most approximates to that found in the advanced economies.

The great shortage of castings in Syria for maintenance, agriculture and other will allow the Pilot Demonstration Foundry (PDF) to operate on a continuous basis and to sell its products, essential for the operation of industry, without competing with other foundries.

Preparation of Specifications

The PDF foundry will be equipped with all the necessary laboratory equipment for its operation. this equipment also will allow the PDF to prepare full metallurgical specifications for metal spare parts by providing a clear definition of:

- Alloy type
- Metallurgical microstructure, and the specification of the heat treatment.
- Mechanical properties of hardness, strength and impact resistance and others such as corrosion resistance etc..
- Production processes which are applicable.

The preparation of specifications will be done for 'in-house' use, for outside industries and as a training and extension programme in order to encourage other industries and institutions to establish these procedures as an essential part of their maintenance programmes, and as the first step in defining their requirements for a spare part.

B.6.2. Implementation Arrangements

The project of establishing a Pilot Demonstration Foundry (PDF) will be geared towards improving the capacity utilization of existing maintenance (repair) workshops by providing them with castings in semi-finished conditions. The castings will undergo a comprehensive testing and be technically certified as to the quality and properties required.

- the project will be programmed and implemented in the two consecutive phases, lasting three months and two years respectively, namely:

(i) preparatory phase
(ii) construction and operation of the Foundry
- establishment of a production volume of castings of 1,000 - 1,500 tonnes/year.
- provision of the machinery and equipment classified into the following groups:

(i) technological machines
(ii) auxiliary technological equipment and special tools
(iii) complete laboratory
(iv) infrastructural equipment (e.g. compressors, transformers, water distribution system, telephone network, etc.)
(v) equipment for environment projection (special filters, water-treatment sytems, etc.)

- as far as possible the procurement of equipment will be made from one source of supply for each of the above classified groups;

- where necessary, the supplier of a given machine and equipment will be responsible for the erection and start-up testing;

- operation of the Foundry and Laboratory will be based on non-profit commercial terms and conditions; i.e. the PDF will be financially self-supporting and provide for investment in new technologies and for training of staff from the income generated from the sale of castings. Therefore, the Government will not provide any subsidy for the operations of the plant, after start-up. However, during the initial period of operation, i.e. the commissioning (12 months), the Government will secure relevant financial credit necessary for the provision of working capital;

- training of staff and/or operators for the enterprises as well as laboratory testing and expertise required by the customers will be carried out at (where justified) locally established commercial rates;

- products of the Foundry i.e. the castings will be sold to the local industries at commercial prices;

B.7. <u>Institutional Arrangements</u>

The Scientific Studies Research Center (SSRC), an institution reporting directly to the Office of the President will be the Government's Executing Agency. The SSRC will co-ordinate this project with the activities of the COmputerized Managed Maintenance project also proposed to be implemented in SSRC, and with:

- Engineering Design Centre, proposd to be establisec through the Ministry of Industry.

- Public Sector Foundry Industries, through the Ministry of Industry.

- Private Sector Foundry Industries, through the Damascus Chamber of Industry.

This will be done through the establishment of an informal committee meeting at least once every two weeks and composed of one representative of each of the groups mentioned. The representatives will be the means of communication of the requiements and programmes of the different interest groups with the PDF but attendance at meetings will not be restricted to these.

B.8. The reasons for external assistance

a. There are two additional projects, Computerised Managed Maintenance, and the Engineering Design Centre promoted by UNIDO and under study within Syria which are associated directly or indirectly with industry operations and maintenance. The efficient co-ordination of the three projects within the objectives of national development is essential and will be facilitatied by implementing them within the framework of UNDP/UNIDO.

b. UNIDO has a successful background in the establishment of foundries, and in sypplying technical assistance to foundries within developing countries.

B.9. Special considerations

a. No special consideration is given to fostering the role of women in the development of the national economy. However, because of the extensive involvement of women in information technology the application of computers to maintenance will permit the increased role of women in the industrial development and in the extension of information technology and management.

b. No specific arrangements are envisaged for the NGO's although and extensive co-operation is expected with the Damascus Chamber of Industry, and the public and provate sector foundries and theproposed project to establish an Engineering Design Centre.

c. Pollution control equipment will be installed as standard.

B.10 Coordination Arrangement

As indicates above, an informal committee will be established and formed of a representative of each of the SSRC, the public sector foundries, the private sector foundries and teh Engineerind Design Centre. This committee will meet to ensure that the activities of the PDF are properly oriented towards the so;ution of the problems of the subsectors and the consumers of castings.

B.11 Counterpart Support Capacity

The Government Executing Agency is the Scientific Studies and Research Centre (SSRC) in Damascus. This Institute is the leading national institute for research and development as well as being a consultancy and training institute. The SSRC has been nominated by the government as the executing agency for several UNDP/UNIDO projects and has a long record of successful co-operation with international institutions and agencies.

The SSRC has at its disposal some 1500 qualified specialists (engineers and technicians) active in many spheres of industrial production and engineering. The SSRC also posesses the necessary technical facilities such as the basic comminications and office automation facilities, training facilities, workshops and technological equipment for pilot scale industrial production. The SSRC also has established a strong, wide network of external consultants, both from within and outside Syria.

The SSRC is implementing projects focussed on mechanical engineering, optical technology, standards and calibration/measurement technology, envirnmental protection, industrial rehabilitation and restructuring etc.. The SSRC thus posesses excellent equipment which is available for special, highly demanding tasks.

C. DEVELOPMENT OBJECTIVE

The development objective of the project is to accelerate economic growth of industry by the increase in the quantity and quality of the local supply of cast spare parts for the Syrian economy.

D. IMMEDIATE OBJECTIVES, OUTPUTS AND ACTIVITIES

D.1. Immediate Objective 1.

The establishment and operation of a Pilot Demonstration Foundry (PDF) manufacturing 1,000/1,500 tonnes of casting per year and preparing metallurgical specifications of metal parts, and:
(i) transferring process and management technology and training supervisory and higher technical and management personnel.
(ii) regularly testing raw materials and products;
(iii) conducting R+D works on upgrading the applied foundry technology in order to diversify the production of new, more sophisticated castings.

D.1.1. Output 1

Preparatory work completed. I.E:
Guiding and Co-ordinatingCommittee selected by the participants, (SSRC, Public and Private Sector Industries), detailed plant design finished and accepted and contract awarded; national staff selected and local and overseas training programmes agreed and training sites approved. Study tours completed. Equipment and technologies selected and orders placed.

ACTIVITIES	Start/End Month	Party Responsible

1.1.1	SSRC to organize a workshop to describe in detail to industry and Government the objectives and activities involved in the project, and to establish full co-ordination with other institutions and projects, notably the Engineering Design Centre at the Ministry of Industry. Selection of Participants by members of Guiding committee.	01.	SSRC
1.1.2	Selection and fielding of CTA;(first mission) Preparation of documentation lists; final determination of equipment specifications with alternatives. Meetings with consumers of castings and the selection of castings to be manufactured during the start-up phase of the project. Selection and ordering of pattern shop equipment.	02-04	UNIDO/SSRC CTA.
1.1.3	Final Selection of counterpart technical and managerial staff, specification of training programmes both within and outside Syria. Preliminary agreement on possible sites.	02-04	SSRC/CTA UNIDO
1.1.4	Study tour arrangements finalized and implemented	02	SSRC/CTA UNIDO
1.1.5	Selection and fielding of foundry design expert.(Mision 1 month), finalization of detailed plant design, with all services. layouts clearly determined together with Syrian civil contractor.	03-03	UNIDO/SSRC
1.1.6	Selection and design of patterns to be manufactured before start-up of the foundry. Preparation of a manufacturing programme within Syria, and for possible subcontracting abroad.	02-22	CTA/SSRC UNIDO
1.1.7	Selection and fielding by month 08 of patternmaker.	03-24	UNIDO/CTA SSRC
1.1.8	Award contract for construction of foundry buildings.	03-04	SSRC
1.1.9	Begin training of technical staff. Note:Training within Syria should begin as soon as possible. and will cover: metallurgy, foundry processes, casting design patternmaking	03-21	UNIDO/SSRC

management,
cost accounting.

1.1.1 0	Construct foundry buildings. beginning with pattern shop and laboratories (pattern shop to be ready by month 8).	04-20	SSRC

D.1.2. Output 2

Operational PDF with Sevices for the Preparation of metallurgical specifications, for the design and production of castings operational, and with all extension services ready with manuals and materials prepared.
Guiding and Co-ordinating Committee members operating as the intermediaries between the Industry, Government and the SSRC. Industries). National staff trained and local and overseas training programmes finalized.

	ACTIVITIES	Start/End Month	Party Responsible
1.2.1	Request quotes for equipment and imported raw materials, analyse, select and place orders. Note that laboratory equipment for immediate delivery.	06-12	UNIDO/SSRC CTA
1.2.2	Deliver foundation plans of machinery to Syrian construction firm; final localization of equipment and power lines etc., on plans. Short return mission of foundry design engineer. Construct as priority pattern shop and laboratory to be ready by month 14.	12-13	UNIDO/SSRC
1.2.3	With laboratory in place, begin providing services to the foundry industry, and initiate the service to consumers of spare parts by preparating metalurgical specifications for spare parts. Begin selecting and checking local raw mateials; advise concerning upgrading required and establish processing procedures for their use in Industry.	15 on	SSRC/UNIDO
1.2.4	Organize seminars and workshops for the introduction of the concepts of metallurgical specification preparation for metal parts, and to advise major consumers, consumer groups and Insitutions concerning the establishment of their own systems. Co-ordinate with the Engineering Design Centre.	18 on	SSRC

1.2.5	Return of CTA	14-32	UNIDO/SSRC
1.3.6	Receive,check, install and recheck equipment, receive and check patterns and matchplates. Review all installations and correct, and adjust as necessary.	18-23	CTA/SSRC
1.2.7	Mission of expert in finance and administration and costing of foundry production. Discussions with consumers of castings, obtain orders. Set up costing system for foundry and establish guidelines for other foundries. Prepare workshop on accounting and costing procedures.	24-27	UNIDO/SSRC
1.2.7	Arrival of expert, foundry training programmes to work with SSRC staff and CTA and industry in the preparation of training programmes for industry. (Note: it is assumed that the expert will have available standard course material which may have to be modified to suit local conditions).	18-22	UNID/SSRC CTA
1.2.9	Arrival of the service staff of the manufacturers of selected equipment, to finalize and check installation and to commission.	23-23	UNIDO/CTA SSRC
1.2.10	Start up of foundry.	24	SSRC/CTA
1.2.11	Organize and hold periodic seminars and workshops for Foundry Industry staff and management.	25 on	SSRC/CTA
1.2.12	Together with Industry, determine the priorities for training.	18-22	TRNG.EXPT CTA/SSRC
1.1.13	Begin consultant missions to solve/advise concerning specific problems.	26 on	SSRC/CTA UNIDO
1.2.13	Begin training programmes.	28 on	SSRC/CTA

E. INPUTS

(a) Government Inputs

The total Government input will by in SYP and convertible currency:

1. Assignment of National Staff — Pounds

The technical administrative support staff as well as lab. assistants, etc., shall be assigned for the project year (total m/m of about 1.400) 8,800,000

2. Project travel

Local expenses of national and internal staff within the country incl. the portion of air-tickets for the international routes covered by the Syrian Airlines 800,000

3. Subcontracts

(i) Subcontract of civil engineering design and constiuction works

Based on the data conceptual design and outlines to be provided by UNIDO subcontractor and terms of reference prepared by UNIDO 62.000.000

(ii) Subcontract of locally fabricated furniture, equipment and tools 9.000.000

Relevant TOR and documentation will be provided by UNIDO project perscnnel.

4. Expendable Equipment/materials

(i) Domestic expenses on imported equipment
Storage, clearing, inland transportation, insurance and other domestic expenses of imported materials and equipment 3,000,000

(ii) Raw and Auxiliary Materials
Provision of sufficient funds will be made in order to procure sufficient stock of raw materials needed for smooth starting of foundry 15,000,000

(iii) Consumables
Sufficient financial resources will be provided for the local purchase of supplies, materials, etc. and also for covering the costs of electricity, water, fuel spare parts, oil and other items needed to operate the foundry/laboratory/pattern-making sections 2,500,000

5. Non-expendable equipment
(i)industrial infrastructure installation, (transformers, compressors, pumps, water-pipeline,

valves, electrical cup boards) 1,600,000

(ii) Auxiliary production and supporting tooling e.g. conveyers, beams and rails for cranes, etc. (a.o. for maintenance services sections)

(iii)Equipment for environment protection (heavy-duty filters, water re-conditioning system, sewage installation, designs to be provided where necessary)

(iv) Means of transportation, vehicles-trucks, bus, electrical platform mini-cars, etc.

(v) Local purchase of patterns and tools.

(iv) Office furniture and clerical facilities (telephone, photo-copiers, computers, telex, type-writers, fire-proof system etc..

6. Maintenance costs of vehicles and project equipment 5,000,000

7. Sundries (contingencies) 13,900,000

TOTAL (SYRIAN POUNDS)

* * *

(b) UNDP Inputs

Project Personnel

11-01	Chief Technical Adviser (CTA) (splitmissions)	18 m/m	$ 240,000
11-02	Expert, Patternmaking	16 m/m	220,000
11-50	short term consultants.	12 m/m	165,000
11-51	Consultant, Finance and Administration and production costing.	3 m/m	
11-52	Consultant, Heat treatment.	3 m/m	
11-53	Consultant, Computerized Casting design	1 m/m	
11-54	Consultant, Metallurgical specifications for spare and other parts for machines and agricultural implements and tools.	3 m/m	
11-55	Other short term consultants	2 m/m	

16-00	UNDP/UNIDO Staff Travel		16,000
31-00	Fellowship Training (30 m/m in Cairo)	60 m/m	205,000
32-00	Study tour.		14,000
41-00	Expendable equipment		40,000
42-00	Non-Expendable Equipment		1,040,000
51-00	Miscellaneous		35,000
99-99	Project total		1,975,000

F. PRIOR OBLIGATIONS AND PREREQUISITES

The prior obligations of the project will be:

1. The counterpart will secure the cost sharing contribution, together with the Government Counterpart Contribution in Cash (GCCC, Syrian Pounds) upon signature of this project document.

2. the Government should early identify the source(s of co-financing the project as indicated under para E. (a) of this document (Section: Government Inputs) and, duly secure the allocation of the required fund.

3. The Government should wholly secure a suitable local contractor to construct the required building(s) and to establish necessary industrial and social infrastructure. The same refers to the source of supply of all the required auxiliary equipment such as electrical transformers, compressors, pumps, fire-proof system, telephone network etc. of which the source of supply should be early identified.

4. The Government will appoint the Project National Director amongst the candidates preferably with a metallurgical engineering background and sufficient experience in industrial management.

The Government should assign to him an adequate authority and authority and clearly define - in a formal nomination document - his duties, rights and responsibilities.

5. The provision of services of interpreter and typist from English to Arabic and vice-versa will be made by the Government.

6. The project document will be signed by the UNDP authorities concerned and UNIDO and, the UNDP assistance to the project will be provided only if the prior obligations stipulated above have been met to UNDP's satisfaction.

G. RISKS.

There are no major risks with this project. however considerable care must be taken to ensure that the Private and Public Sector industries are involved in the project from the beginning; this covers not only the fondry

A.Buckle/rg/7.11.91

EQUIPMENT LIST

SYRIA: Pilot Demonstration Foundry - SSRC

Melting	US$	US$
Induction Melting furnace (One power unit with 3 crucibles, 700, 500, 300 kg)	335,000	375,000
Refractory	3,000	
Ladles *)	15,000	
Transfer/pouring systems	10,000	
Weighing scales *)	2,000	
Fume and dust extraction equipment *)	10,000	
Sand Preparation		135,000
Mixer	25,000	
Sand transport and storage, extraction equipment *)	80,000	
Shake out	10,000	
Core sands (silicate, resin, shell)	20,000	
Moulding		195,000
4 Jolt squeeze	80,000	
Moulding boxes *)	50,000	
Roller conveyors *)	25,000	
Core blowers	30,000	
Mould handling equipment *)	10,000	

<u>Cleaning and Finishing</u>		60,000
Cut-off	10,000	
Snag grinders *)	7,000	
Swing grinder	7,000	
Shot blast	36,000	
2 overhead cranes, 5 ton (imported inputs only)	30,000	
<u>Heat Treatment</u>		25,000
Furnaces *)	20,000	
Quenching tanks *)	5,000	
<u>Laboratory</u>		160,000
Sand laboratory	39,000	
Metallographic sample preparation	15,000	
Microscope	6,000	
Hardness tester (portable and static)	10,000	
Chemical: Carbon and sulphur determinator.	25,000	
Atomic absorbtion spectrometer	65,000	
<u>Technologies</u>		60,000
Ceramic mould (precision) casting - materials and technology (additional equipment not required).	30,000	
*) Investment (lost wax) casting. Technology, equipment design, limited import of parts for equipment	40,000	
<u>Consumables.</u> imported materials and technical literature.		40,000
	Total	1,080,000

Notes:

A. Items marked with asterisk (*) are those which may be largely purchased or manufactured within Syria. Where local manufacture is contemplated, the costs shown cover design and include a provision for parts which may be imported.

B. The purchase of 'works reconditioned' equipment, (i.e., reconditioned by the original manufacturer and with guarantee) will result in savings.

C. An atomic absorbtion spectrometer (AAS) is included for chemical analysis of metal. An emission spectrometer will be more convenient, but the cost (above $ 200,000 with calibration) is too high and the AAS is adequate for most castings which are manufactures using high quality scrap and other inputs of known composition.

D. Hand tools and minor equipment, electrical cables, switchgear, will be provided by the counterpart.

Appendix 5

REFERENCE DOCUMENTS/PUBLICATIONS

1. UNIDO Terms of Reference

2. Statistics Books, 1987, 1988, 1989, 1990; publication of the Government of Syria

3. Feasibility Study Report on PDF; by the Experts Team of SSRC Damascus, 1991

4. Technology Profile on Mini Foundries; UNIDO 1987

5. Metal Production Development Unit, New York, United Nations 1982

6. Personnel and Training Needs in Iron and Steel Industry UNIDO, 1986

7. UNIDO Report on Establishment of Pilot Demonstration Foundry in Ethiopia (by GEMCO ENG. BV, SON, The Netherlands) 1990

8. UNIDO Report on Establishment of a Pilot Foundry Laboratory in Mongolia, 1989

9. Guidelines for Establishing a Demonstration Foundry in a Developing Country, UNIDO, Vienna, 1976

10. Manual for Evaluation of Industrial Projects, UNIDO, Vienna, 1980

PERSONS MET / INSTITUTIONS VISITED

1. Dr. A.W. Chahid, President SSRC Damascus, General Director of the Centre
2. Dr M. MRayati, Higher Institute of Applied Sciences and Technology, Damascus
3. Mr. Albula Hagona, Deputy Resident, Representative UNDP-Damascus
4. Ms. Mouna Kallas, SSRC Scientific Co-Operation Dept.
5. Dr A. Bakkar, Team Leader SSRC Experts
6. Dr Salah-Eddine Mohamed-Ali, Head SSRC Mechanical Dept.
7. Eng. G.Ghadban, SSRC Expert
8. Dr J. Turjman, SSRC Expert
9. Eng. M. Zeidan, SSRC Expert
10. Mr. E.Salloun, SSRC Public Relation Dept.
11. Dr Khaled Alloush, UNDP Damascus
12. Ms. Nadia Kozak, UNDP Damascus
13. Miss Shaereen Mahmoold, SSRC
14. Dr Abdallah Jabbour, Studies/Engineering Consultants of the Military Housing Establishment, Damascus
15. Eng. Georges Beshara, SAMAWI Foundry Damascus
16. Mr. Rateb Kayall, Foundry Consultant, SAMAWI Foundry
17. Dr Tatal Yossef, Millihouse Production Tech. Dept., Damascus
18. Dr Said Al-Hebri, Millihouse Foundry Dept, Damascus
19. Eng. Hisham Hamed, Adra Cement Foundry
20. Eng, Mandoh Abou Al-Resh, Adra Cement Foundry
21. Mr. Ali Al-Yousef, State Fertilizers Factory, Homs
22. Mr. Tarik Zeny Ziad Spai, Refinery, Homs
23. Mr. Abdoul Al-Azis Al Haj, Sugar Factory, Homs
24. Ziad Kotainy, Steel Mills Metallurgical Plant, Hama
25. Dr Talal Hassan, Tractors and Agricultural Machinery Plant, Aleppo
26. Eng Mechal Jourjos, Railways - Transportation Company, Aleppo
27. Mr. Mouhamed Al-Nakesh, Private Steel Foundry, Aleppo
28. Eng. Ali Shamma, Electrical Motors Factory, Lattakia
29. Eng. Khamel Maklouf, Aluminium Factory, Lattakia

OCTOBER 1985 THE BRITISH FOUNDRYMAN

The influence of climatic temperature and humidity on the bond strength of cores made from some cold-hardening chemical binders

by K. E. L. Nicholas* & A. J. Briggs**

The authors are *leader moulding materials group and **former member of research department Staff BCIRA

Synopsis

The extent to which variations in atmospheric temperature and humidity affect the curing rate and strength properties of cores made from five different cold hardening chemically bonded sands has been investigated by the use of a climatic cabinet in which cores could be stored in temperature and humidity controlled atmospheres. Five different atmospheres were employed, and the results assessed by determination of the changes in core strength and weight.

Major differences in curing rates and final strengths observed were in direct consequence of independent changes in ambient temperature and relative humidity. The results indicate that foundries using cold hardening chemical binders would benefit from close control of the temperature and humidity in mould and core making shops; the same control is necessary in laboratories where chemical binders are tested.

Introduction

The increasing use of cold-setting chemical binders for mould and core production has alerted many foundries to problems caused by changes in day-to-day operating conditions: for example, temperature. Most foundries are well aware that changes in sand temperature cause corresponding alterations in the catalyst requirement and the hardening characteristics. Less is known about the consequences of variations in the atmospheric temperature or the relative humidity, within a foundry, on the curing rate or bond strength of cold-set binders. Unless the magnitude of these changes is known, the strength and storage properties of moulds and cores cannot be accurately predicted. A further problem is that properties determined on cold-set chemical binders in well-heated or air-conditioned laboratories give a false impression of the properties actually achieved in a foundry during production — where atmospheric conditions are likely to be more variable.

In the course of testing many different chemical binders, BCIRA has become aware that inconsistencies in results occurred as a result of relatively small changes in the laboratory atmosphere. To ensure consistency in results, therefore, BCIRA has installed a large climatic cabinet in which test cores can be stored at constant predetermined temperatures and humidities, independent of changes in the laboratory atmosphere. Equally important is the ability to reproduce a wide range of atmospheric conditions, so that corresponding changes in curing rates and final strength can be determined.

In the work which is the subject of the present paper, the cabinet has been used in the latter capacity—to reproduce the variations in atmospheric temperature and relative humidity that are likely to be encountered in foundries. The materials tested included two acid-catalysed furan resins, an ester-hardened silicate, and two CO_2-silicate compositions.

Use of the climatic cabinet

The cabinet shown in Fig. 1 incorporates [illegible] temperatures ranging from −25°C to +100°C to be maintained. The lowest humidities that can be maintained in the cabinet range from 50 per cent at 5°C to 10 per cent at 80°C: at the other extreme, 100 per cent humidity can be maintained over the temperature range 10 to 70°C. The cabinet has a capacity of 0.28m³.

The temperature within the cabinet is varied by adjustable contact thermometers; the required relative humidity is controlled by presetting a wet-bulb contact thermometer to maintain a calculated temperature difference from the dry-bulb thermometer. The specified relative humidity is maintained automatically by injection of atomised water into the chamber, or use of the refrigeration system to lower the humidity.

The conditions maintained within the cabinet for the present series of tests were:

Series 1. Cabinet temperature 20°C, relative humidity 40 per cent.

Series 2. Cabinet temperature 20°C, relative humidity 60 per cent.

Series 3. Cabinet temperature 20°C, relative humidity 80 per cent.

Series 4. Cabinet temperature 30°C, relative humidity 40 per cent.

Series 5. Cabinet temperature 10°C, relative humidity 60 per cent.

Materials tested

Five cold-set binders were tested, the composition of the mixtures being:

1 Chelford 60 silica sand + 2.0 per cent UF/FA resin (8.2 per cent nitrogen and 13.1 per cent water) + 50 per cent phosphoric-sulphuric acid catalyst (based on resin weight).

2 Chelford 60 silica sand + 2.0 per cent PF/FA resin (zero nitrogen and 14.1 per cent water) + 30 per cent para-toulene sulphonic acid (based on resin weight).

3. Chelford 60 silica sand + 3.5 per cent 2.5:1-ratio sodium silicate (56 per cent water) + 0.35 per cent (based on sand weight) proprietary ester hardener.

4 Chelford 60 silica sand + 3.5 per cent 2.0:1-ratio sodium silicate (54 per cent water), CO_2-gas hardened.

5 [illegible] 2.5:1-ratio sodium silicate (56 per cent water), CO_2-gas hardened.

Investigation

Some 50 x 50 mm (2 x 2in) cylindrical AFS compacts were rammed, from each of the five sand mixtures, and changes in compression strength were determined as hardening proceeded while the test cores were stored in the climatic cabinet at the specified temperature and humidity. In all instances, sand at room temperature, 20-25°C, was used in preparing the mixtures, for each specimen of 164g.

The three self-setting mixtures were used immediately after mixing, specimens being rammed in rapid succession before the bench-life of a mixture was exceeded. In all cases it was possible to ram between six and eight specimens within five minutes of making the individual mixtures. Each specimen was accurately weighed, and immediately transferred to the climatic cabinet. At regular intervals specimens were removed from the cabinet, re-weighed, and the compression strength determined.

Fig. 1 Climatic cabinet used [illegible]

All specimens made by the CO_2-silicate process were gassed at a CO_2-gas flow rate of 2.5 l/min and 70 kpa (10 lbf/in²) pressure. Each specimen was weighed after gassing, and changes in weight were determined at intervals of 24 and 48 hours' storage at the required temperature and humidity. Compression strengths were determined in the as-gassed condition, and after storage for 24 and 48 hours.

All five binders were tested simultaneously under the same temperature and humidity conditions. The climatic cabinet was brought to the required temperature and humidity before each test run was commenced. Throughout the tests the cabinet maintained close control of temperature and humidity, temperature variations being within 2.0°C, while the relative humidity fluctuated less than 3 per cent.

Table I Changes in compression strength and weight loss for UF/FA resin-bonded cores during curing and storage.

Temperature / Relative humidity	20°C 40%		20°C 60%		20°C 80%		30°C 40%		10°C 60%	
Storage time	Strength, kN m² (lbf in²)	Weight loss, g	Strength, kN m² (lbf in²)	Weight loss, g	Strength, kN m² (lbf in²)	Weight loss, g	Strength, kN m² (lbf in²)	Weight loss, g	Strength kN m² (lbf in²)	Weight loss g
15 min	7 (1)	-0 05	28 (4)	—	0 (0)	—	28 (4)	-0 10	0 (0)	-0 05
30	280 (41)	-0 10	470 (68)	-0 20	110 (16)	-0 10	1 190 (173)	-0 15	55 (8)	-0 05
1 h	1 720 (250)	-0 15	1 940 (281)	-0 25	1 870 (271)	-0 10	3 900 (565)	-0 30	780 (113)	-0 10
2	5 430 (787)	-0 25	3 850 (558)	-0 25	3 790 (549)	-0 05	6 560 (952)	-0 55	2 120 (308)	-0 15
4	7 054 (1 023)	-0 40	5 680 (824)	-0 30	5 080 (737)	0 0	8 930 (1 295)	-0 55	3 900 (565)	-0 20
5	7 743 (1 123)	-0 40	6 120 (888)	-0 30	—	—	—	—	4 490 (651)	-0 25
6	—	—	—	—	—	—	9 720 (1 410)	-0 60	—	—
24	10 160 (1 474)	-0 55	8 000 (1 160)	-0 45	6 690 (970)	-0 10	11 450 (1 660)	-0 70	8 440 (1 224)	-0 50
48	11 000 (1 596)	-0 55	8 240 (1 195)	-0 35	7 450 (1 080)	-0 05	11 650 (1 689)	-0 70	8 040 (1 166)	-0 50

Table II Changes in compression strength and weight loss for PF/FA resin-bonded cores during curing and storage.

Temperature / Relative humidity	20°C 40%		20°C 60%		20°C 80%		30°C 40%		10°C 60%	
Storage time	Strength, kN m² (lbf in²)	Weight loss, g	Strength, kN m² (lbf in²)	Weight loss g	Strength, kN m² (lbf in²)	Weight loss, g	Strength, kN m² (lbf in²)	Weight loss g	Strength, kN m² (lbf in²)	Weight loss, g
15 min	145 (21)	—	28 (4)	—	28 (4)	—	120 (17)	-0 15	0 (0)	-0 05
30	1 100 (160)	-0 10	320 (47)	-0 15	440 (64)	-0 10	1 170 (170)	-0 30	34 (5)	-0 10
1 h	2 960 (429)	-0 25	980 (142)	-0 25	970 (140)	-0 10	2 170 (314)	-0 40	324 (47)	-0 15
2	4 240 (615)	-0 35	2 500 (362)	-0 45	2 050 (298)	-0 15	5 030 (730)	-0 55	930 (135)	-0 25
4	4 490 (651)	-0 55	3 940 (572)	-0 45	3 160 (458)	-0 25	6 660 (966)	-0 75	2 090 (303)	-0 35
5	5 470 (794)	-0 55	3 850 (558)	-0 45	3 550 (515)	-0 35	—	—	3 300 (479)	-0 40
6	—	—	—	—	—	—	6 020 (873)	-0 75	—	—
24	4 990 (723)	-0 60	4 780 (693)	-0 55	5 230 (758)	-0 40	8 340 (1 209)	-0 80	6 070 (880)	-0 65
48	—	—	6 410 (930)	-0 55	5 420 (786)	-0 35	6 560 (952)	-0 70	5 230 (759)	-0 65

Table III Changes in compression strength and weight loss for ester-hardened sodium-silicate-bonded cores during curing and storage.

Temperature / Relative humidity	20°C 40%		20°C 60%		20°C 80%		30°C 40%		10°C 60%	
Storage time	Strength kN m² (lbf in²)	Weight loss g	Strength kN m² (lbf in²)	Weight loss, g	Strength kN m² (lbf in²)	Weight loss g	Strength kN m² (lbf in²)	Weight loss g	Strength, kN m² (lbf in²)	Weight loss g
15 min	228 (33)	-0 15	476 (69)	—	190 (28)	—	390 (57)	-0 20	300 (44)	-0 15
30	790 (114)	-0 25	1 300 (189)	-0 20	986 (143)	-0 05	1 540 (223)	-0 35	830 (120)	-0 15
1 h	1 700 (247)	-0 35	2 010 (292)	-0 30	2 020 (293)	-0 10	2 020 (293)	-0 60	1 580 (229)	-0 15
2	2 240 (325)	-0 65	1 590 (231)	-0 40	2 480 (359)	-0 10	3 010 (437)	-0 80	1 780 (258)	-0 25
4	2 920 (424)	-0 90	2 420 (351)	-0 50	2 940 (427)	-0 15	4 690 (680)	-1 10	1 920 (279)	-0 40
6	3 500 (508)	-1 10	2 810 (408)	-0 70	—	—	5 180 (751)	-1 30	2 720 (394)	-0 45
24	4 14[illegible] ([illegible])	-1 50	3 300 (479)	-0 90	4 240 (615)	-0 15	7 050 (1 023)	-2 00	3 850 (558)	-1 00
48	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Findings

Changes in compression strengths and weight loss for the three self-hardening mixtures are compared in Tables I, II & III. The changes in properties, as curing proceeded in the first six hours, are listed together with the values over the succeeding 48 hours of storage in the same climatic conditions. The effects of changes in climatic condition on the initial curing rates of these three self-hardening systems are illustrated in Figs. 2, 3, & 4.

The strength and weight changes determined for the CO_2/silicate-process cores bonded with 2.0:1- and 2.5:1-ratio sodium silicates are recorded in Tables IV & V for the full range of temperature and humidity variation studied.

Discussion of findings

Within the first six hours, the curing rates of the two acid catalysed resins and the ester-hardened sodium silicate were very significantly affected by changes in the temperature and humidity of the surrounding air. The largest differences in curing rates occurred with the two cold-set resins and, in both cases, increasing the relative humidity from 40 to 80 per cent at a constant temperature of 20°C, or lowering the temperature in the cabinet from 30 to 10°C, reduced the hardening rate. The extent of the difference in curing rates for these two resins is demonstrated in Figs. 2 & 3, which show that after two hours the strengths in each case varied by 4 100 kN/m² (600 lbf/in²(at the extreme climatic conditions.

Cores made by the ester-hardened silicate process were apparently less sensitive than the resin-bonded cores to the same changes in temperature and humidity. After curing for two hours, strengths varied by only 1 400 kN/m² (200 lbf/in²) at the extreme conditions but, as hardening proceeded, cores maintained at 30°C and 40 per cent humidity developed particularly high strengths, (Fig. 4).

While increases in humidity at constant temperature caused measurable reductions in the curing rates, changes in atmospheric temperature were responsible for major alterations in strength. In all three cold-set systems, a high atmospheric temperature (30°C) accelerated curing throughout the initial 5- or 6-hour period, while a decrease to 10°C severely retarded hardening.

The three self-hardening systems appeared to reach equilibrium strength values within 24 hours at all the various climatic conditions studied, and extending the storage period to 48 hours produced relatively little change. However, the individual 24-hour and 48-hour equilibrium strengths differed greatly, depending upon the climatic conditions used for storage. The strength differences observed within the first six hours persisted during the following 48-hour storage period. Outstandingly high strengths resulted when cores were stored at 30°C, and there was no indication that these values would be ultimately matched by prolonged storage at lower temperature or higher humidity.

The CO_2-silicate process cores also appeared to reach equilibrium strength values during the initial 24-hour period of storage. Cores stored at 30°C and 40 per cent humidity achieved much higher strengths than similar cores stored at lower temperatures or higher humidities, and again there was no indication that longer storage under these adverse conditions would lead to improvement. As expected, cores bonded with the 2.0:1-ratio sodium silicate had higher 24- and 48-hour strengths than the corresponding series of cores bonded with the 2.5:1-ratio silicate.

With the various binder systems studied, all the cores lost weight during storage, high temperature and low humidity being responsible for the greatest weight loss.

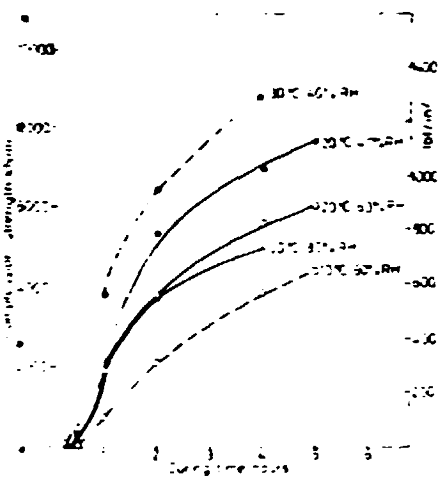


Fig. 2 Effect of climatic conditions on the curing rate of cores bonded with UF/FA resin.

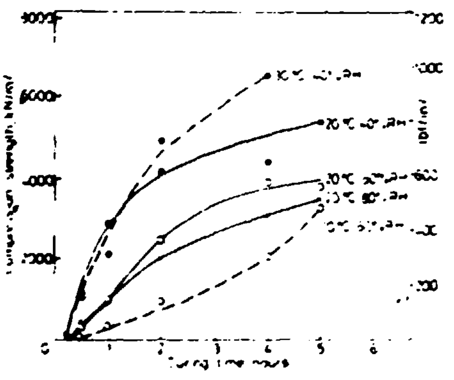


Fig. 3 Effect of climatic conditions on the curing rate of cores bonded with PH/FA resin.

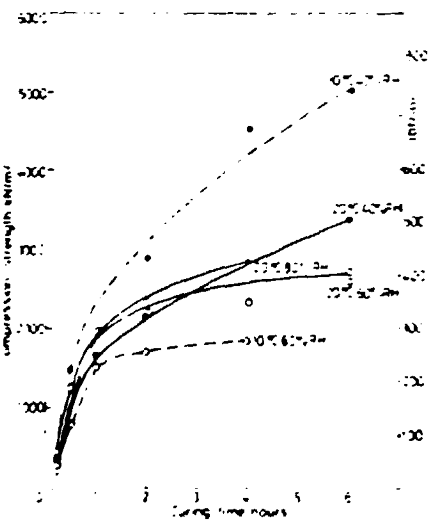


Fig. 4 Effect of climatic conditions on the curing rate of cores bonded with ester silicate.

Table IV Changes in compression strength and weight for CO_2-silicate (2.0:1 SiO_2:Na_2O ratio) bonded cores during storage.

Temperature: Relative humidity:	20°C 40%		20°C 60%		20°C 80%		30°C 40%		10°C 60%	
	Strength, kN m² (lbf in²)	Weight change, g	Strength, kN m² (lbf in²)	Weight change, g	Strength, kN m² (lbf in²)	Weight change, g	Strength, kN m² (lbf in²)	Weight change, g	Strength, kN m² (lbf in²)	Weight change, g
As-gassed										
30 s	390 (56)	+0·20	500 (73)	+0·20	370 (54)	-0·15	300 (44)	-0·20	270 (39)	-0·20
60 s	1 080 (156)	+0·25	1 260 (183)	+0·30	1 120 (162)	-0·30	945 (137)	-0·30	830 (120)	-0·30
24 h storage										
30 s	5 130 (744)	-1·95	4 120 (597)	-1·05	3 980 (577)	-0·30	7 900 (1 145)	-1·80	5 470 (794)	-0·75
60 s	3 580 (519)	-1·95	2 030 (294)	-0·85	3 760 (545)	-0·55	3 800 (551)	-1·90	4 100 (594)	-0·70
48 h storage										
30 s	5 380 (780)	-2·00	4 660 (676)	-1·06	3 400 (493)	-0·70	8 832 (1 281)	-1·80	6 070 (880)	-0·90
60 s	3 900 (566)	-2·00	3 040 (441)	-0·95	1 720 (250)	-0·70	5 580 (809)	-1·90	3 360 (487)	-0·90

Table V Changes in compression strength and weight for CO_2-silicate (2.5:1 SiO_2:Na_2O ratio) bonded cores during storage.

Temperature Relative humidity	20°C 40%		20°C 60%		20°C 80%		30°C 40%		10°C 60%	
	Strength kN m^{-2} (lbf in^{2})	Weight change, g	Strength kN m^{-2} (lbf in^{2})	Weight change g	Strength, kN m^{-2} (lbf in^{2})	Weight change g	Strength kN m^{-2} (lbf in^{2})	Weight change, g	Strength kN m^{-2} (lbf in^{2})	Weight change g
As gassed										
20 s	1090 (158)	-0.15	1130 (164	-0.15	1020 (148)	-0.15	970 (141)	-0.20	1000 (145)	-0.20
40 s	1570 (228)	-0.20	1570 (228	-0.20	1560 (226)	-0.25	1500 (218)	-0.25	1500 (217)	-0.25
24 h storage										
20 s	2300 (333)	-2.10	2140 (311)	-1.30	1560 (226)	-0.80	4300 (623)	-2.10	2810 (408)	-1.05
40 s	1310 (190)	-2.10	1510 (219)	-1.30	1590 (230)	-0.85	2610 (379)	-2.05	1580 (229)	-1.05
48 h storage										
20 s	2640 (383)	-2.15	1970 (285	-1.40	1940 (282)	-0.95	4100 (594)	-2.15	2220 (322)	-1.25
40 s	1480 (215)	-2.15	1260 (18[illegible]	-1.45	1685 (243)	-0.95	2860 (415)	-2.10	1430 (208)	-1.3[illegible]

Since all the binders contained appreciable quantities of water, the weight losses recorded must be primarily connected with water evaporation from the cores, although other volatile constituents such as formaldehyde and furfuryl alcohol might account for some of the weight reduction. Even in the most adverse conditions, of 80 per cent relative humidity, none of the cores increased in weight — which indicates that no water absorption occurred.

Although the strongest resin- or silicate-bonded cores lost most in weight during storage, there is no clear correlation between strength and weight loss for any of the binder systems studied. However, the weight loss from a core during storage is a good indication of the environment in which a core has been stored, and this could be used as a simple control test to determine the extent of climatic variations within a core shop. The present results clearly indicate that warm, dry conditions which permit the maximum weight loss from a mould or core will ensure the highest strengths, and probably the longest shelf-life without deterioration.

Foundries troubled by low strengths, surface or edge friability, and rapid deterioration of cores should consider the economics of providing warm, dry conditions in which to store their cores. In view of the much higher strengths which can be achieved in such conditions, some reduction in binder content may be possible to offset the costs of providing additional heat in the core store.

Finally, it must be concluded that all testing of cold-set chemical binders should be carried out at controlled temperatures and humidity, or the results obtained will have little significance. When the results of such tests are reported the environmental conditions should be stated.

Conclusions

1 The curing rates and final strength of moulds and cores made from cold-set resin or sodium silicate bonded sand mixtures are significantly affected by changes in the ambient temperature and relative humidity.
2 High ambient temperatures accelerate curing rates and ensure maximum strength development from a binder. To a lesser extent, low atmospheric humidity promotes similar changes.
3 The high strengths achieved by storing cores in warm dry atmospheres cannot be matched by prolonged storage in more adverse conditions.
4 Cores bonded with furane resins or sodium silicate lose weight owing to evaporation of volatile constituents, solvents or water during curing and storage. The extent of the weight loss is determined by the atmospheric temperature and relative humidity in which curing or storage occurs.
5 Laboratory tests should be carried out at controlled temperatures and humidity if consistent results are to be obtained, and these conditions should be reported with the bonding properties.

Acknowledgement

The authors wish to thank the director and council of BCIRA for permission to publish this paper.

NOTE
on the counterpart institution

The Scientific Studies & Research Center (SSRC) was founded in Damascus in 1969. The law stipulating SSRC creation, was subjected to amendments in 1972 and 1983, entailing the extension of its objectives to include research, experimental development, scientific training and industrialization. In order to fulfill its objectives, SSRC was granted the status of an independent scientific body. The SSRC conducts applied scientific research and experimental development with the aim of furthering Syria's progress.

The Center also places great emphasis on the acquisition, transfer and adaptation of technology. It is further interested in developing management science and techniques, and industrial engineering.

The SSRC is managed by a "Board of Directors" composed of the directors of affiliated institutes and some academic figures. The Chairman of the board is the General Director of the Center.

The activities of the SSRC are focused on applied sciences and technology as well as management and some economic issues. The Center also seeks to develop and promote some industries, particularly in the electronics field. It plays a pioneering role in the development of the applied science and technology infrastructure of the country through post-graduate training and education in the Higher Institute of Applied Science and Technology (HIAST). It also endeavours to improve the quality of intermediate education to meet the needs of research and development laboratories, particularly in modern specializations whose spread is still limited in both the public and private sectors.

The SSRC collaborates with different public sector institutions for conducting a number of applied studies and research. It also supervises the training of technicians from different ministries of the state.

The Center, too, has strong relations of cooperation with Arab, regional and international scientific institutions for the purpose of developing and guiding scientific staff, and promoting scientific collaboration ties.

Its principal activities towards the industrialization of the country are as follows:

- linking research and development activities with industry, on limited and subsystem scales,

- transfer of new technologies and their application in industry,

- design of technological plans for industrial operations,

- assisting the public sector in conducting technological studies for industrial projects and providing production equipment for these projects.

LIST OF TABLES

Table No

1. Castings demand in Syria
2. Overall castings production /PDF 500/
3. Projection of castings butch production /PDF 500/
4. Projection of castings production /PDF 1500/
5. Specification of machinery/equipment
6. Raw materials requirement /overall requirement/
7. Annual raw materials requirement /local/imported/
8. Training requirement I /managerial/senior staff members/
9. Training requirement II /supervisory staff/skilled workers/
10. Comparison of investment capital expenditures - see page 15 of the report
11. Basic characteristics of iron castings groups
12. Application of cast iron
13. Application of steel castings
14. American specifications for steel castings /ASTM Standards/
15a. Customers Codes
15b. Steel castings production /PDF 500/
16. Steel castings production /PDF 1500/
17. Cast iron production /PDF 1500/
18. Sensitivity analysis; Internal Rate of Return; PDF 500/PDF 1500 - - see page 20 of the Terminal Report
19. Production/sales; PDF 1500
20. Production/sales of steel castings /in consecutive years of operation/ PDF 1500
21. Production/sales of iron castings /in consecutive years of operation; PDF 1500
22. Structure of production costs - see page 21 of the Terminal Report
23. Investment and sources of required finance - see page 22 of the Terminal Report
24. Balance of metal charge - page 29 of Annex 1
25. Comparison of the main sand moulding processes
26. Comparison of the main sand core-making processes

27. Characteristics of core-sand moulding methods
28. Summary of features of main sand binder systems
29. Foundry patterns requirement
30. Manpower requirement

Table 1

Castings Demand in 1991
as per Syrian Industries

in tonnes

Industry /Corporation, establishment company/	Identified			Estimated		
	steel castings	iron castings	TOTAL	steel castings	iron castings	TOTAL
Agriculture Mechanization	600	103	703	1.500	500	2.000
Cement Industry	2.383	-	2.383	10.000	-	10.000
Chemical Industry	72	93	165	500	600	1.100
Food Processing Industry	-	22	22	100	100	200
Geological and Mineral Processing Industry	22	22	44	150	150	300
Roads/Bridges Construction Enterprises	68	436	504	1.000	3.000	4.000
MATA Co. - Maintenance of Public Transportation Means	50	27	77	50	27	77
MILIHOUSE - General Civil Eng./ Construction Co.	82	68	150	82	68	150
Port Authorities	15	15	30	15	15	30
Railway Co.	50	1.000	1.050	50	1.000	1.050
Petrochemical Industry	470	270	740	1.500	1.000	2.500
Sugar Industry	45	33	78	500	300	800
Transport Industry	190	300	490	200	300	500
HAMA Steel Plant	-	-	-	4.000	1.500	5.500
Private Sector	-	-	-	1.500	500	2.000
Other unspecified castings users	-	-	-	11.853	7.940	19.793
GRAND TOTAL	4.048	2.389	6.437	33.000	17.000	50.000

Table 2

Overall castings production

/PPF 500 T capacity/

in tonnes

Type of production	Projected tonnage in consecutive years				
	1	2	3	4	5
Batch	170	270	365	440	470
Jobbing	30	30	35	40	60
TOTAL	200	300	400	480	530

Table 3

Projection of castings batch production

/PPF 500 T capacity/

Weight groups of castings		Consecutive year 1	2	3	4	5
		Tonnes				
up to 5 kgs	I	6.5	12.0	15.0	28.0	33.0
5 - 25 kgs	II	46.5	76.0	100.0	122.0	122.0
25 - 100 kgs	III	85.0	125.0	170.0	180.0	190.0
100 - 300 kgs	IV	32.0	61.0	80.0	110.0	125.0
Sub-total	-	170.0	275.0	365.0	440.0	470.0

Table 4

Projection of castings production
/PPF 1500 T/

Weighting group	Tonnage of castings in consecutive years /tonnes/									
	Year 1		Year 2		Year 3		Year 4		Year 5	
	Steel	Iron	Steel	Iron	Steel	Iron	Steel	Iron	Steel	Iron
I up to 5 kgs	15	-	30	-	35	8	40	15	60	30
II 5 - 25 kgs	102	-	123	-	150	45	200	65	250	90
III 26 - 100 kgs	175	-	180	-	270	80	360	130	400	180
IV 101 - 300 kgs	71	-	130	-	135	70	170	100	200	120
Jobbing type castings	17	-	17	-	30	17	30	40	90	80
Sub-total iron/steel castings	380	-	480	-	620	220	800	350	1000	500
Total castings	380		480		840		1.150		1.500	

Table 5

Specification of

machinery, equipment and tools

/PPF: 500 t and 1500 t capacity/

Item	Description	Steel casting Dept. Quantity PPF 500 T	Steel casting Dept. Quantity PPF 1500 T	Cast iron Dept. Quantity PPF 1500 T	Remarks	Procurement costs /estimated CIF prices/
1	2	3	4	5	6	7
1.	Scrap Yard					
	Oxy-acetylene aggregate					1.500
	Platform-scale	1	1			500
2.	Melting Shop					
	Electric Arc Furnace 1.5 t	1	1			180.000
	Induction Melting Furnace 500 kg			1		100.000
	Boltom pouring ladle with lining	3	4	-		1.500
	Tea-pot 1 t ladle	-	-	1		700
	Drum ladle 0.5 t	-	-	2		1.000
	Hand ladle 50 kg	5	5	5		300
	Slag ladle /cast iron/	2	2	-	Locally fabricated	
	Platform scales 200 kg	1	1	-		500
	Ladle drying stand	1	1	-	Locally fabricated	
	Electric drier for stoppers /200 x 1200 x 1700/	1	1	-	Locally fabricated	
	Muller mixer capacity 150 liters	1	1	-		4.000
	Overhead bridge crane:					
	Q 3,2 T	1	-	-		15.000
	Q 5,0 T	-	1	1		20.000
	Lifting magnet	1	2	-		15.000
	Fork-lift trucks Q = 1200 kg	1	1	-		8.000
	Cast iron inoculation drum ladle 1 t	-	-	1		8.800

1	2	3	4	5	6	7
3.	<u>Machine moulding Section</u>					
	Jolt-squeeze pin-lift moulding machine:					
	Moulding table:					
	600 x 400	1	-	1		20.000
	900 x 600	1	1	-		25.000
	1100 x 900	-	1	-		30.000
	Moulding boxes:					
	600 x 400	30	-	-		100
	800 x 600	30	30	45		150
	1100 x 900	-	30	-		250
	Pallets for mould:					
	800 X 600	30	30	45	Locally fabricated	
	1100 x 900	-	30	-	Locally fabricated	
	Set of roller tables:					
	B = 650	15 m	20 m	30 m		1 m = 500
	B = 2 x 400	20 m	-	-		
	B = 2 x 650	-	30 m	-		
	Hoist block 500 kg	2	2	1		2.000
	Hopper, capacity V = 3 cu.m. ofer moulding machines	4	4	2	Locally fabricated	
	Free-standing pneumatic crane 1000 kg	2	2	1		3.500
4.	<u>Hand moulding Section</u>					
	Moulding boxes	15	30	20		400
	Pallets for mould	10	10	10	Locally fabricated	
	Sand slinger				Self hardening moulding	8.000
5.	<u>Chill Moulds Section</u>					
	Casting machine /flange mould/	1	1	-		20.000
	Casting machine /cement crushing ball moulds/	1	1	-	Semi-chill moulding technique	20.000
6.	<u>Shell moulding stand</u>					
	Shell moulding machine	1	1	-		40.000

1	2	3	4	5	6	7
7.	Core making Section					
	Muller mixer capacity 150 l	1	1	-		15.000
	Swing mixer capacity 80 l	1	1	-		10.000
	Speed muller mixer	-	1	-		18.000
	Table-type core blower with attachment for hot-box	3	5	-		15.000
	Coremarker's bench	3	5	-	Locally fabricated	
	Electric rack-type drier 1700 x 2400 x 1700	1	1	-	Locally fabricated	
	Core rack 1100 x 800 x 1300	30	50	-	Locally fabricated	
	Fork-lift track Q = 1200 kg	1	2	1		8.000
	Free-standing pneumatic crane Q = 500 kg radius 3500 mm	1	1	-		3.500
	Mould and core coating mixer capacity 180 l	1	1	-		10.000
8.	Fettling and heat treatment Section					
	Airless shot-blasting machine	-	1	-		20.000
	Two-table airless shot blasting machine, max loading 1000 kg	1	1	-		25.000
	Air operated shot-blast cabinet-table capacity 2000 kg	-	1	-		
	Table for knocking out cores 1500 x 800 x 500	3	6	3	Locally fabricated	
	One-wheel grinding machine	2	3	2		2.500
	Abrasive cutting off machine	1	2	1		2.500
	Single girder crane Q 3,2 t	1	1	1		15.000
	Electric welding machine	1	2	-		7.000
	Welders table 1200 x 750 y 600	-	2	-	Locally fabricated	
	Liquid fuel-fired, car bottom chamber furnace with set of control and measuring apparatus	1	2	-		40.000
	Water tank for cooling of castings	-	1	-	Locally fabricated	
	Oil tank for quenching of castings	-	1	-	Locally fabricated	
	Dust collector	-	4	-	Locally fabricated	

1	2	3	4	5	6	7
9.	Sand conditioning plant with sand distribution and sand dry' ; system					250.000
	Sand distributic.. and return belt conveyors L = 150 m	1	1	-		
	Sand distribution and return belt con/eyors B = 500 mm Lc = 30 m 2 pcs	1	1	-		
	Belt feeders L = 6-7 m	1	1	-		
	Box-type feeders	1	2	-		
	Muller mixer 600 L	-	2	-		
	Muller mixer 250 L	2	-	-		
	Core sand mixer 85 L	1	2	-		
	Facing sand conditioning mixer 170 L	1	1	-		
	Magnetic separator	1	1	-		
	Rotary screen output 20 m^3/h	1	1	-		
	Basket type elevator 15t/h	1	1	-		
	Fluidized-bed drier and cooler 2-5 t/hr /liquid fuel fired/	1	1	-		
	Aerator, output Q = 40 cu.m/hr	1	1	-		
10.	Pattern making shop					
	Wood - lathe	1	1	-		180.000
	Double-spindle shaper	2	2	-		
	Band-saw	1	1	-		
	Panel planer	1	1	-		
	Surfacer	1	1	-		
	Circular saw	1	1	-		
	Double-wheel grinder	1	1	-		
	Profile grinder					
	Carpentier bench	4	7	-	Locally fabricated	
	Bench plate	1	1	-		
	Battery platform car	1	1	-		
	Storage rack	1	1	-	Locally fabricated	

1	2	3	4	5	6	7
11.	Maintenance Section					250.000
	Instruments Calibration Section					100.000
	Pilot Laboratory	1	1			350.000
	Express Laboratory /Sand propertics/metal composition/	1	1	-		100.000
	Industrial Infrastructure Equipment /water pumps, air compressors, transformers, etc./	1	1	-		150.000
	De-dusting system Water re-conditioning Air conditioning					

Table 6

RAW MATERIALS REQUIREMENT

	500 T Foundry T/years	1500 T Foundry T/years
Steel scrap	700	1.430
Pig-iron	100	330
Cast iron scrap	-	500
Ferro-alloys	40	100
Refractory materials	50	120
Limestone	30	50
Iron ores	100	200
Silica sand	100	210
Fine clay (binder)	10	20
Bentonite	30	70
Natural organic binders	5	10
Sodium silicate	15	40
Other (auxiliary) materials	10	2

Table 7

Annual Raw Materials Requirement

	PPF 500			PPF 1500	
	Unit price	Quantity /tonnes/	Procurement cost	Quantity /tonnes/	Procurement cost
Local supply					
Return steel scrap	2.580	280	776.000	850	2.193.000
Purchased steel scrap	4.100	400	1.640.000	970	3.977.000
Silica sand	2.150	100	215.000	210	452.000
Bentonite	2.150	30	64.000	70	150.000
Cast iron scrap	10.000	155	1.550.000	400	4.000.000
Other materials			1.265.000		1.628.000
TOTAL SYP			5.510.000		12.400.000
Imported materials					
Pig iron	300	100	30.000	330	100.000
Ferro-alloys	5.500	40	22.000	100	250.000
Iron ore	80	100	8.000	200	16.000
Refractory materials	250	50	12.500	120	30.000
Graphite powder	2.500	10	25.000	25	62.000
Chemical resins	8.000	15	120.000	35	304.000
Sodium silicate	1.000	15	15.000	45	45.000
Blasting shot	2.500	10	25.000	25	63.000
Other materials			25.000		45.000
TOTAL USD			480.000		915.000

Table 8

TRAINING REQUIREMENT I
/Managerial and Senior staff members/

Post occupied /Trainee/	Group study tour	Individual fellowship programme	UNIDO - In-plant training programmes
Manager PPF	x	x	x
Production Engineer	x	x	x
Laboratory /Quality Control Engineer	x	x	
Maintenance Services Engineer		x	
Senior Designer /Process Designing, Programming R/D/		x	x
Superintendent Pilot Laboratory		x	
Quality Inspector		x	

Table 9

TRAINING REQUIREMENT II

/Supervisory staff and skilled workers/

Post occupied by trainee	Group study tour	Individual fellowship programme	UNIDO In-plant training programmes	In-plant group training		On-the-job training	
				Local	Abroad	Local	Abroad
Laboratory Assistant		x					
Maintenance Service Mechanic						x	
Maintenance Service Electrician						x	
Electronic Technician						x	
Foundry Process Designer		x	x				
Pattern-maker					x	x	
Moulding Machine Operator					x	x	
Smelter /furnace operator/					x	x	
Core - maker					x	x	
Hand - moulder					x	x	x
Ladle mason				x		x	
Ladle operator				x		x	
Operator heat-treatment oven							

Basic characteristics of iron castings groups, as influences in selection

Alloy type	Main positive characteristics	Examples of applications emphasising main characteristics
Grey cast iron	Low cost combined with appreciable hardness, tensile strength and rigidity; high compressive strength; high damping capacity and thermal shock resistance; excellent founding qualities for complex designs	Manhole cover; tunnel segment; lathe bed; i.c. cylinder block; brake drum; ingot mould; gear blank; piston ring
Ductile, malleable and special cast iron	Higher tensile strength with ductility; wear resistance; corrosion resistance; low or moderate cost	Crankshaft; agricultural implements; ball mill liner; pump and valve components for acid plant
Cast steel /carbon and low alloy/	High yield and tensile strength stiffness and strength-weight ratio, combined with toughness and fatigue resistance, at moderate cost	Track link; aircraft undercarriage member; mill housing; die block; heavy duty gear blank
High alloy cast steel	Corrosion resistance under a wide range of conditions; resistance to high temperature creep and oxidation; abrasion resistance	Water turbine runner; pump and valve components; gas turbine casing; radiant tube; tube support; carburising box; excavator bucket lip; rock crusher jaw

Application of cast iron

Service requirements to working conditions	Examples of castings belonging to these groups	Features of castings belonging to these groups	Grade /chemical composition/	Grade of alloys	Kind of moulds
2	3	4	5	6	7
Steady stresses at normal temperature	Housings, casings, municipal and wetaer works, light compressors	Soft castings as cast or annealed, good machinability	ASTM A-4864	Gray iron	Sand /Dies/ /Centrifugal/
Steady stresses at elevated temperature	Cylinder blocks, heads, oil pump bodies, gear boxes, light duty brake drums	Machinability, pressure tightness, strength	BS 1452-61	Gray iron. High carbon desired to eliminate hot cracks.	Sand /Sand with chills/ /Dies/ /Centrifugal/
Wear at elevated temperature	Brake drums and clutch plates under heavy duty service. Diesel, engine castings. Liners, pistons, heavy gear boxes	As above, wear resistance. Resistant at elevated temperature	ISO/TP-185	Sometimes use of alloying elements	
Dynamic stresses at normal temperature and wear	Camshafts, cylinder liners. Hardenable alloy gray iron castings containing carbides	Machinability. Wear resistance. Strength at elevated temperature	DIN 1964	Low alloy gray iron. Sometimes heat treated	Sand /Shell-moulds/ /Dies/ Sand with chills
Corrosion at normal temperature and wear	Pump bodies, pipes and other castings for use at elevated temperature to resist acid caustic and salt solutions	Resistant to corrosion and wear	BS 3468	High alloy gray iron	Sand moulds
Corrosion at elevated temperataure	Valve guider, piston rings, pump bodies, impellers	Resistant to corrosion and wear at elevated temperature	BS 3468	As above	Sand moulds
Wear at normal temperature	Abrasion resisting castings for general use. Grinding balls	Wear resistance. Hardness	ISO 2892	High alloy white iron Cr, Ni, Mo /Hardened/	Sand Chill cast. Dies
Wear at elevated temperature + dynamic stresses	Glass rolls and moulds, gauges, required minimum expansion	Resistance at elevated temperature	ISO 2892	High alloy gray iron	Ceramic moulds Chill cast
Corrosion at normal temperature	Pumps and piping for corrosive liquids	Corrosion resistance	ISO 2892	Low alloy gray iron	Sand moulds /Centrifugal/
Corrosion at elevated temperature + internal pressure	Castings for chemical industry. /Non-magnetic valve housing/	Resistant to corrosion at elevated temperature	ASTM A 296-53T	High alloy gray iron /Ni, Cr, Cu/	Sand moulds
Internal pressure at normal temperature	Valve and pump bodies. Pressure castings	Strength. Tightness	ASTM A 486-63T	Low alloy ductile iron	Sand moulds
Internal pressure at normal temperature + wear	Shipboard electric equipment, compressors	Wear resistance. Strength Tightness	ASTM A 487-63T	Low alloy ductile iron /annealed/	Sand moulds /Dies/
Steady stresses at elevated temperature + internal pressure	Pressure containing parts for use at elevated temperature	Strength at elevated temperature. Notch toughness is needed Tightness	ASTM 389-60T	As above	As above
Internal pressure at elevated temperature	Valves, flanges, pipe fittings and other piping components	Strength at elevated temperature Tightness Shock resistance	ASTM 386-60T	As above	As above

Application of steel castings

No	Service requirements working conditions	Examples of castings belonging to these groups	Features of castings belonging to these groups	Some features according to chemical composition and others	
1	Steady stresses at normal temperature	Gear wheels, housings, holders, parts of electric machines	Weldability, use to carburizing	0.15 - 0.20% C carbon steel	Intricatool-shape castings with small sections
2	Dynamic stresses at normal temperature	Bodies, frames, bases, pedestals, gear wheels, sprocket wheels	Weldability Strength	0.25 -0.30% C carbon steel	Castings exposed to rupture strokes
3	Dynamic stresses and internal pressure at elevated temperature	Bodies, parts of fittings, parts of turbines, ships and locomotives parts	High hardness Strength at elevated temperature	0.35 - 0.40% C carbon steel	Simple shape castings of high hardness requirement
4	Wear was not caused by any dynamic stresses at normal temperature	Rolls, parts of crushers, mills and excavators	High hardness	0.50 - 0.59% C carbon steel	As above but without any dynamic stresses
5	Dynamic stresses and wear at normal temperature	Locomotives parts, trucks, parts of crushers, elevators	High hardness High mechanical properties Wear resistance	0.30 - 0.40% C 1.20 - 1.60% Mn	Sensitive to overheating by heat treatment
6	Wear and dynamic stresses at elevated temperature	Parts of furnaces	Wear resistance	0.25 - 0.30% C 0.5 - 0.8% Cr	For castings not exposed to dynamic stresses
7	Dynamic stresses at elevated temperature	Parts of turbines	Strength at elevated temperature	0.25 - 0.4% C 0.8 - 1.1% Cr 0.2 - 0.3% Mo	Especially for castings where the homogeneity of structure is required
8	Steady stresses at elevated temperature	Parts of large machines	Good machinability Wear resistance Strength at elevated temperataure	1.0 - 1.5% Cr 3.0 - 4.5% Ni 0.2 - 0.4% Mo	Castings of relatively large sections /300 - 400 mm/
9	Corrosion at normal temperature	Ship-building and other applications for navy shipboard	Resistant to sea water Good mechanical properties	0.15 - 0.3% C 1.5% Cu	
10	Heat shock and not exposed to dynamic stresses	Parts of furnaces and furners	Heat-resistant Strength at elevated temperature	0.4 - 0.6% C 1.3 - 1.8% Si 16.5 - 17.5% Cr	
11	Heat shock and dynamic stresses	Drums and barrels for chemical industry reports	As above and resistance to the gases with sulphur	0.3 - 0.5% C 1.3 - 1.5% Si 26.0 - 28.0% Cr 3.5 - 4.5% Ni	
12	Corrosion at elevated temperature	Parts for water turbine and steam turbine	Corrosion resistant Heat resistant Good mechanical properties at elevated temperature	0.2 - 0.3% C Mn 1.0% Si 1.5% 12.5 - 14.5% Cr Ni 1.0%	
13	Wear at normal temperature and at very high dynamic stresses	Parts of crushers, mills, teeth of excavators, track chains	Wear resistance	1.2 - 1.6% C 12.0 - 14.0% Cr	/ev. 3.5% Co; 0.2% V/
14	Wear at elevated temperature and high dynamic stresses	Roll forging, pilgrim rolls, drawing plugs	Wear resistance High strength properties at elevated temperature	1.6 - 1.8% C 22.0% Cr 1.5 % Ni 2.2 % W 2.0 % Co 0.5 % V	

Table 14

SOME OF AMERICAN SPECIFICATIONS FOR STEEL CASTINGS

Carbon and Low Alloy Cast Steel

ASTM	A 27-62 Mild to Medium-Strength Carbon-Steel Castings for General Application.
ASTM	A 148-60 High-Strength Steel Castings for Structural Purposes.
ASTM	A 216-63T Carbon Steel Castings Suitable for Fusion Welding for High Temperature Service.
ASTM	A 217-60T Alloy Steel Castings for Pressure Containing Parts Suitable for High Temperature Service.
ASTM	A 352-60T Ferritic Steel Castings for Pressure Containing Parts Suitable for Low Temperature Service.
ASTM	A 356-60T Heavy-Walled Carbon and Low Alloy Steel Castings for Steam Turbines.
ASTM	389-60T Alloy Steel Castings Specially Heat Treated for Pressure Containing Parts Suitable for High Temperature Service.
ASTM	A 486-63T Steel Castings for Highway Bridges.
ASTM	A 487-63T Low Alloy Steel Castings Suitable for Pressure Service.
SAE	1962 Automotive Steel Castings.
AAR	M 201-62 Steel Castings.

High Alloy Cast Steels

ASTM A 128-60	Austenitic Manganese Steel Castings.
ASTM A 296-63T	Corrosion-Resistant Iron-Chromium and Iron-Chromium-Nickel Alloy Castings for General Application.
ASTM A 297-63	Heat Resistant Iron-Chromium and Iron-Chromium-Nickel Alloy Castings for General Application.
ASTM A 351-63T	Ferritic and Austenitic Steel Castings for High Temp. Service.
ASTM A 447-50	Chromium-Nickel-Iron Alloy Castings (25-12 Class) for High Temp. Service.
ASTM 448-50	Nickel-Chromium-Iron Alloy Castings (35-15 Class) for High Temp. Service.
MILITARY	MIL-S-16993 A December 1954 Steel Castings 12 per cent Chromium).
	MIL-S-867 A December 1951 Steel Castings Corrosion Resisting Austenitic.

Table 15a

CUSTOMER CODES NUMBERS

01	-	Agricultural Mechanization
02	-	Cement Plant(s)
03	-	Chemical Industry
04	-	Food Processing Industry
05	-	Geological Enterprises
06	-	"KASSIOUN" - Road & Bridge Construction Corporation
07	-	Mineral Processing Industry
08	-	M.A.T.A. Company - Automobile/Vehicles Maintenance Service
09	-	Milihouse - Building Construction Co.
010	-	Sea Port Authority
011	-	State Railways Co.
012	-	Refinery(s)
013	-	Sugar Plant(s)
014	-	Transport Establishment
015	-	Other, unspecified

Table 15b

Weighting Group I

Steel castings production
/PPF 500/

Code No	Description of casting	Unit weight /kg/	Production in consecutive years /in kgs/ 1	2	3	4	5	Remarks
			kgs/year					
1	2	3	4	5	6	7	8	9
01/18	Sprocket	4	1.200	1.200	1.200	1.200	1.200	
01/26	Linking parts	5	2.000	2.000	2.000	2.000	2.000	
01/29	Gears	5	1.000	2.500	2.600	2.600	2.600	
01/11	Adapter	1	1.000	1.000	1.000	1.000	1.000	
02/3	Crushing balls	3	1.500	1.500	1.500	15.000 x	20.000 x	
03/20	Sleeve bushes	3	-	1.500	1.500	1.500	1.500	
03/17	Pump impeller	3	-	175	175	175	175	
03/21	Bearing body	3	-	500	500	500	500	
03/22	Compling	3	-	300	300	300	300	
01/4	Chaing bushing	2	-	1.000	4.000	4.000	4.000	
	TOTAL		6.700	11.675	14.775	28.275	33.275	

x Centrifugal chill moulding technique applicable as optional alternative.

Weighting group II

1	2	3	4	5	6	7	8	9
012/3	Flanges	15	30.000	30.000	30.000	50.000 x	50.000 x	
012/9	Gate valves	15	5.250	5.250	7.650	7.650	7.650	
012/10	Globe valves	15	5.250	5.250	7.650	7.650	7.650	
01/22	Plates	13	4.500	4.500	4.500	4.500	4.500	
01/12	Scarfier cover	10	1.500	1.500	1.500	1.500	1.500	
012/12	Diffusers	15	-	500	500	500	500	
012/15	Linners	15	-	500	500	500	500	
012/16	Fan slades	15	-	2.000	2.000	2.000	2.000	
01/1	Truck chain plates	25	-	12.500	25.000	25.000	25.000 xx	
01/2	Chain part	8	-	8.000	16.000	16.000	16.000	
01/18	Sprockets	12	-	6.000	6.000	7.200	7.200	
	TOTAL		46.500	76.000	101.300	122.500	122.500	

x Centrifugal chill moulding technique

xx Shell moulding

Weighting group III

1	2	3	4	5	6	7	8	9
02/1	Cooler plates	50	5.000	6.000	7.000	8.000	9.000	
02/2	Furnace plates	60	27.000	27.000	27.000	27.000	27.000	
02/5	Standard threholds	75	5.500	5.500	5.500	5.500	5.500	
02/6	Toaer chutes	90	4.500	6.000	7.000	8.000	9.000	
06/5	Excavator teeth	35	11.250	11.250	36.000 x	36.000 x	36.000 x	
03/7	Gears	60	11.250	11.250	11.250	11.250	11.250	
08/3	Mixer axles	30	5.500	5.500	5.500	5.500	5.500	
08/4	Sprockets	50	15.000	15.000	15.000	[illegible].000	15.000	
01/24	Plow blade arms	35	-	3.500	3.500	3.500	3.500	
09/9	Scarfier tips	60	-	2.000	2.000	2.000	2.000	
01/10	Scarfier teeth	70	-	14.000	15.000	18.000	20.000	
06/4	Excavator blades	35	-	11.250 x	22.500 x	22.500 x	22.500 x	
05/6	Forks	62	-	4.500	4.500	4.500	4.500	
05/7	Bearing cap	70	-	3.500	3.500	3.500	3.500	
012/12	Diffusers	65	-	-	1.000	1.000	1.000	
012/14	Gear box	65	-	-	1.000	1.000	1.000	
012/13	Pump parts	75	-	-	5.000	7.000	10.000	
	TOTAL		85.000	126.250	173.250	179.250	186.250	

x Shell moulding technique applicable as optional alternative

Weighting group IV

1	2	3	4	5	6	7	8	9
03/7	Gear	110	5.500	5.500	5.500	5.500	5.500	
03/10	Engine cover	135	1.000	1.000	1.000	1.000	1.000	
05/19	Cone	140	3.500	3.500	3.500	3.500	3.500	
05/17	Gear	130	2.000	2.000	2.000	2.000	2.000	
05/1	Driving gear	180	2.700	2.700	2.700	2.700	2.700	
012/9	Gate valve	170	8.500	8.500	13.600	8.500	13.600	
012/10	Globe valve	170	8.500	8.500	13.600	8.500	13.600	
03/3	Engine base cover	200	-	3.000	4.000	7.000	10.000	
05/23	Digger pic set	250	-	12.500	12.500	25.000	25.000	
06/6	Crushing plate	150	-	10.000	18.000	18.000	18.000	
09/20	Gear	100	-	4.000	4.000	4.200	4.200	
012/12	Diffusers	100	-	-	-	500	500	
012/13	Pump case parts	166	-	-	-	10.000	10.000	
012/14	Gear box	150	-	-	-	600	600	
02/6	Tower	150	-	-	-	9.000	9.000	
02/5	Standard threholds	110	-	-	-	2.200	2.200	
02/8	Gear	200	-	-	-	4.000	4.000	
	TOTAL	-	31.700	61.200	80.400	112.200	125.400	

Table 16

Weighting group I

Steel castings production - PPF 1500 t

ode o	Description of casting	Unit weight /kg/	Production in consecutive years /kgs/ 1	2	3	4	5	Remarks
			kgs/year					
1	2	3	4	5	6	7	8	9
1/18	Sprocket	4	1.200	1.200	1.200	1.500	2.000	
1/26	Linking parts	5	2.000	2.000	2.000	2.500	3.500	
1/29	Gears	5	2.600	2.600	2.600	3.000	5.000	
1/11	Adapter	1	1.000	1.000	1.000	1.200	2.000	
2/3	Crushing balls[x]	3	1.500	1.500[x]	20.000[x]	25.000	35.000	
3/20	Sleeves, bushes	3	1.500	1.500	1.500	1.500	2.500	
3/17	Pump impeller	3	175	175	175	200	500	
3/21	Bearing body	3	500	500	500	500	1.000	
3/22	Coupling	3	300	300	300	300	500	
/4	Chaing bushing	2	4.000	4.000	4.000	4.000	6.000	
	TOTAL		15.000	30.000	35.000	40.000	60.000	

Weighting group II

1	2	3	4	5	6	7	8	9
012/3	Flanges	15	30.000	50.000	65.000	75.000	90.000	
012/9	Gate valve	15	7.650	7.650	8.000	10.000	12.000	
012/10	Globe valve	15	7.650	7.650	8.000	10.000	12.000	
01/22	Plates	13	4.500	4.500	5.500	6.000	8.000	
01/12	Scarifiers cover	10	1.500	1.500	2.000	2.500	4.000	
012/12	Diffuser	15	500	500	1.000	1.200	2.000	
2/15	Linners	15	500	500	500	800	1.200	
012/16	Fun blade	15	2.000	2.000	2.000	2.500	4.000	
01/1	Truck chain plate	25	25.000	25.000	30.000	45.000	60.000	
1/2	Chaing part	8	16.000	16.000	16.000	20.000	30.000	
01/18	Sprocket	12	6.000	6.000	7.200	9.000	15.000	
	TOTAL		**102.000**	**123.000**	**150.000**	**200.000**	**250.000**	

Weighting group III

02/1	Cooler plate	50	7.000	8.000	15.000	25.000	30.000
02/2	Furnance plate	60	27.000	27.000	35.000	50.000	60.000
02/5	Standard theholds	75	5.500	5.500	10.000	10.000	10.000
02/6	Tower chute	90	7.000	8.000	16.000	30.000	30.000
06/5	Excavator teeth	35	36.000	36.000	45.000	60.000	80.000
03/7	Gears	60	11.250	11.250	18.000	25.000	25.000
08/3	Mixer axles	30	5.500	5.500	7.500	10.000	10.000
08/4	Sprocket	50	15.000	15.000	20.000	20.000	20.000
01/24	Plow blade arm	35	3.500	3.500	5.000	5.000	5.000
01/9	Scariefiers tip	60	2.000	2.000	2.000	2.000	2.000
01/10	Scariefiers teeth	70	16.000	18.000	45.000	70.000	70.000
5/4	Excavator blade	35	11.250	22.500	25.000	25.000	25.000
05/6	Fork	62	4.500	4.500	4.500	4.500	4.500
5/7	Bearing cup	70	3.500	3.500	3.500	3.500	3.500
012/12	Diffuser	65	1.000	1.000	2.000	2.000	2.000
012/14	Gear box	65	1.000	1.000	2.000	2.000	2.000
012/13	Pump parts	75	5.000	7.000	7.000	10.000	10.000
	TOTAL		175.000	180.000	270.000	360.000	400.000

Weighting group IV

1	2	3	4	5	6	7	8	9
03/7	Gear	110	5.500	5.500	5.500	6.500	8.000	
03/10	Engine cover	135	1.000	1.000	1.000	1.500	2.000	
05/19	Cone	140	3.500	3.500	3.500	4.000	6.000	
05/17	Gear	130	2.000	2.000	2.000	2.500	2.500	
05/1	Driving part of gear	180	2.700	2.700	2.700	3.000	5.000	
012/9	Gate valve	170	8.500	13.600	13.600	15.000	20.000	
012/10	Globe valve	170	8.500	13.600	13.600	15.000	20.000	
03/3	Engine base cover	200	4.000	7.000	10.000	12.000	15.000	
05/23	Digger pic set	250	12.500	25.000	25.000	30.000	35.000	
06/6	Crusher plate	150	18.000	18.000	18.000	28.000	30.000	
09/20	Gear	100	4.000	4.200	4.200	6.000	6.500	
012/12	Diffusers	100	-	500	500	1.000	1.000	
012/13	Pump cast parts	160	é	10.000	10.000	12.000	12.000	
012/14	Gear box	150	-	600	600	1.000	1.000	
02/6	Tower	150	-	9.000	19.000	20.000	25.000	
02/5	Standard threholds	110	-	2.200	2.200	2.300	2.500	
02/8	Gear	200	-	4.000	4.000	5.000	5.500	
	TOTAL		71.000	130.000	135.000	170.000	200.000	

Table 17

Cast iron production - PPF 1500 T

Weighting group I

Pattern Code No	Description of casting	Unit weight /kg/	Production in consecutive years /in kgs/ 1	2	3	4	5	Remarks
			kgs/year					
1	2	3	4	5	6	7	8	9
01/28	Pulley´s Ø 100	3			150	400	500	
01/27	Flange´s	3			150	250	300	
01/32	Housing´s	3			150	150	150	
03/26	Sleeve´s, bushe´s	3			1500	1500	1500	
o3/27	Bearing bodies	3			250	300	300	
03/28	Couplings	3			250	300	300	
07/2	Bushing	5			1500	1500	1500	
07/3	Bearing cap	5			500	500	500	
07/4	Gear´s	5			250	250	250	
07/7	Grinding disc	5			500	500	500	
014/6	Flanges	3			2000	2000	4000	
03/30	Wheel Ø 150	3				1000	2000	
08/5	Pistons, cylinders Ø 95	4				2000	6000	
014/5	Cylinder	5				3000	6000	
014/6	Flange	3					4000	
	TOTAL				8000	15000	30000	

Weighting group II

1	2	3	4	5	6	7	8	9
01/28	Pulley´s	10			1.000	1.300	1.300	
09/36	Cover	12			500	750	1.000	
09/33	Trolley wheel Ø 40	18			500	1.000	1.800	
09/27	Wheel Ø 400	18			500	1.000	1.800	
09/20	Gears	15			2.000	2.500	3.800	
08/1	Mixer pulley	20			2.000	3.000	5.000	
08/2	Crane pulley	10			2.000	3.000	5.000	
03/2	Pump seals	20			3.000	4.000	6.000	
03/5	Engine support	25			4.000	4.500	5.000	
03/6	Valve cover	20			4.000	4.500	5.000	
03/29	Wheels-toothed	20			4.000	4.000	4.000	
013/3	Coupling	10			4.000	4.000	5.000	
014/4	Clutch pressing plate	17			5.000	10.000	17.000	Chill casting
011/2	Brake shoes	8			10.000	20.000	30.000	
	TOTAL				45.000	65.000	90.000	

1	2	3	4	5	6	7	8	9
05/10	Socket	32			1.000	1.60	1.600	
05/15	Driving plate	30			2.500	3.000	3.600	
01/28	Pulley Ø 300	57			4.000	4.000	5.000	
01/5	Chain pulley	40			4.000	5.000	6.000	
01/6	Two-strand chain pulley	50			6.000	8.000	10.000	
03/4	Vibrators arm	50			3.000	3.000	3.000	
03/12	Pump axe bousing	40			7.000	8.000	10.500	
03/13	Rubber die casting	37			2.000	2.000	2.000	
03/16	Oil conteiner cover	50			2.500	3.500	4.500	
03/30	Wheels	40			6.000	7.000	8.000	
04/4	Gears	40			2.000	2.000	2.000	
04/6	Teethed wheel	35			2.000	2.800	2.800	
04/7	Container cover	60			2.000	2.500	3.000	
04/10	Flanges	50			2.000	2.000	2.000	
013/8	Wheels	70			5.000	6.000	7.000	
013/10	Bearing bodies	50			4.000	4.000	5.000	
014/1	Brake drum	50				20.000	30.000	Chill casting technique
014/2	Brake drum	38				5.000	10.000	Chill casting technique
06/2	Flat grating	77			20.000	25.000	35.000	Ductile iron/Chill castings
06/3	Mould for tile blocks	34			5.000	5.000	10.000	Ductile iron
012/1	Gate valve	80				4.000	5.000	
	Globe valve	80				5.000	10.000	
	TOTAL				80.000	130.000	180.000	

Weighting group IV

1	2	3	4	5	6	7	8	9
09/22	Spiral bacle holder	100			500	800	1.000	
09/39	Rigars	180			20.000	30.000	40.000	
07/5	Wheel	200			2.000	3.000	4.000	
03/1	Pump coupling	180			7.000	8.000	9.000	
03/8	Base plate	180			3.000	3.000	4.000	
03/9	Pump housing	240			3.000	4.000	5.000	
03/14	Gear	150			1.500	1.500	1.500	
04/7	Container cover	150			5.000	6.000	7.500	
05/9	Cylinder	100			1.000	1.500	2.500	
05/13	Clutch disc	200			6.000	8.000	10.000	
05/14	Driving elements for pump	100			1.200	1.200	1.200	
06/1	Inspection cover	180			20.000	30.000	34.000	Chill casting
	TOTAL				70.000	100.000	120.000	

Table 19

Production/sales
/PPF 1500/

	Year 1	Year 2	Year 3	Year 4	Year 5
Production /t/					
A - steel castings	380	480	620	800	1.000
B - iron castings			220	350	500
Production - Total	380	480	840	1.150	1.500
Sales					
A - steel castings	103.200	130.720	170.280	220.160	275.845
B - iron castings			20.200	32.300	47.400
Sub-Total plus	103.200	130.720	190.480	252.460	323.245
Laboratory services/ Technology transfer	800	1.280	2.520	3.540	5.755
TOTAL sales	104.000	132.000	193.000	256.000	329.000

Production and sales of steel castings
/PPF 1500 T/

Price group /SYP/T/	Year 1		Year 2		Year 3		Year 4		Year 5	
	Tonnes	SYP /.000/	Tonnes	SYP /.000/	Tonnes	SYP /.000/	Tonnes	SYP /.000/	Tonnes	SYP /.000/
193.500	80	15.480	1000	19.350	120	23.220	150	29.025	180	34.830
258.000	160	41.280	200	51.600	260	67.080	340	87.720	430	110.940
322.500	110	35.475	140	45.150	180	58.050	230	74.175	290	93.525
365.500	30	10.965	40	14.620	60	21.930	80	29.240	100	36.550
Sub-total	380	103.200	480	130.720	620	170.280	800	220.160	1000	275.845
Laboratory service Technology transfer		800		1.280		1.720		1.840		3.155
TOTAL		104.000		132.000		172.000		222.000		279.000

Table 21

Production and sales of iron castings
/PPF 1500 T/

Price group /SYP/T/	Year 1		Year 2		Year 3		Year 4		Year 5	
	Tonnes	SYP /.000/	Tonnes	SYP /.000/	Tonnes	SYP /.000/	Tonnes	SYP /.000/	Tonnes	SYP /.000/
50.000	-	-	-	-	40	2.000	70	3.500	100	5.000
80.000	-	-	-	-	80	6.400	120	9.600	160	12.800
110.000	-	-	-	-	80	8.800	120	13.200	160	17.600
150.000	-	-	-	-	20	3.000	40	6.000	80	12.000
Sub-total	-	-	-	-	220	20.200	350	32.300	500	47.400
Laboratory service Technology transfer						800		1.700		2.600
TOTAL						21.000		33.000		50.000

Table 25

Comparison of the Main Sand Core Making Processes (approximate and depending upon the alloy to be cast)

Core making process	Core size limitations	Type of core box	Hardening System	Core box tie-up period	Cores ready for pouring	Rate of core production	Dimensional accuracy (cores)	Surface finish (casting)	Ease of core knockout
Oil sand	Very small to medium	Not critical. Wood: Resin: Metal.	Heat	Few seconds to blow core	Few hours	Slow to very rapid	Poor to good	Good	Good to very good
Air-setting oil sand	Medium to large	Wood	Oxidising agent and heat	30 min to 4 hrs	Several hours	Very slow	Moderate	Good	Good
Shell cores	Very small to small	Metal	Heat	2 to 4 mins	Immediately	Very rapid	Excellent	Excellent	Excellent
Hot box cores	Very small to small	Metal	Heat	5–60 secs	Immediately	Extremely rapid	Excellent	Very good	Very good
Cold-setting sands	Small to very large	Wood: Resin.	Acid catalyst or tertiary amine	5 min to 4 hours	Few hours to 16 hours	Slow to rapid	Very good	Good	Good to very good
CO_2 process	Small to very large	Wood: Resin	CO_2 gas	10 sec to 4 min	Immediately to several hours	Very rapid	Very good	Good	Poor to moderate
Gas hardening Cold processes	Small to medium	Wood: Resin: Metal	Tertiary amine vapour or SO_2 gas	20 sec to 1 min	Immediately	Extremely rapid	Excellent	Very good	Very good

Table 26

COMPARISON OF THE MAIN SAND MOULDING PROCESSES (approximate and depending upon the alloy to be cast)

Moulding Process	Casting weight	Number of Castings		Type of pattern	Relative cost		Dimensional accuracy (casting)	Surface finish (casting)	Relative ease of changing design in production
		min.	max.		in small numbers	in quantity			
Green sand	0.025 kg to 1 tonne	1	Limited to pattern life	Wood Resin Metal	Low	Lowest	Poor to very good	Poor to very good	Poor to good
Dry sand	1 tonne to 100 tonne	1	Limited to pattern life	Wood	High	Highest	Poor to moderate	Good	Very good
Cement sand	1 tonne to 50 tonne	1	Limited to pattern life	Wood	High	High	Moderate	Good	Very Good
CO_2 Process	0.025 kg to 20 tonne	1	Limited to pattern life	Wood Resin	High	Low	Good	Very good	Very good
Cold-set sands	0.025 kg to 200 tonne	1	Limited to pattern life	Wood Resin	High	Low	Good to very good	Very good	Very good
Shell moulding	0.025 kg to 100 kg	500	Limited to pattern life	Metal	Highest	Low	Excellent	Excellent	Very poor
V-Process	200 kg to 10 tonne	1	Limited to pattern life	Wood	Low	High	Very good	Very good	Very good
Expendable pattern (a) Bonded sand	20 kg to 20 tonne	1	5	Polystyrene	Lowest	Very high	Poor to good	Poor to good	Excellent
(b) Unbonded sand (vacuum)	1 kg to 250 kg	500	20,000+	Polystyrene	Very high	Low	Very good	Very good	Very poor

Table 27

Characteristics of core sand moulding methods

Method	Main variants of the method	Core material	Comments	Core-box material	Other required operations and equipment	Advisability for developing countries
1	2	3	4	5	6	7
By hand						
Using moulding profiles	Sweep, template /single or multiple/	Natural or synthetic, oil-sand or highly refractory special sand	Large size and minimum series cores	Wood	Baking arbors	Processes require skilled labour
By lathe	Vertical or horizontal axis	Natural or synthetic sand	Small series, large circular segment cores	Wood	Baking, centrally supported spindle	
Skeleton		Synthetic and oil-sand or highly refractory mixtures	Minimum series, large cores	Wood	Baking, many reinforcing rods	
In core box	The core box structure may have movable parts	Cement, CO_2-silicate, oil-sand. No-bake	Several dimensions small series	Wood	Baking, oil moulding requires reinforcing rods	For small series with large dimensions
Jolt machine	Core box rollover and hauling is mechanized	Synthetic or natural sand	Cheap, small series production	Wood, plastic /some metal/	Baking, special reinforcing stalks	Not advisable
Air compression						
Single post machine		Oil-sand, CO_2-silicate Hot box, or cold box. No-bake	Medium series production. All operations in sequence	Metals /some wood/	Baking according to mixture	
Double post		Generally hot or cold hardening mixtures	Medium to large series. Alternative operations	Metal, complicated core boxes	Baking on machine if required	Not advisable
Multiple posts			Large to very large series. Distributed operations	Sophisticated cast-iron or steel core boxes	Baking on machine, if required	Not advisable

1	2	3	4	5	6	7
Swing slinger	Ancillary equipment includes a rotatory table, and a roll-over for continious cycle	Synthetic sand and oil-sand	Flexible for medium series with core box rotation	Wood, plastic, metal /aluminium/, boxes Average cores	Baking, reinforcing rods	Versatile but subject to tool wear and need for rotating impellers
Continuous mixer	Uses simultaneous binder addition or pre-mixing	No-bake mixtures /plastics,catalysts/	Surface precision flexibility for small medium series cores	Wood, plastic /some metal/, Good equipment life		Many advantages

Summary of features of main sand binder systems

	Clay-bonded sands		CO_2 Process	Air-set Process	Oil + starch Binders	Shell Process	Hot box Process
	Green sand	Dry sand					
Material costs	Low	Low	Moderate	High	Mod.	High	High
Pattern or corebox costs	Low	Low	Low	Low	Low	High	High
Costs of machines	Low Hand High Machine	Low Hand	Low	Moderate	Low Hand	High	High
Level of skills	High Hand Low Machine	High	Low	Low	Moderate	Low	Low
For small moulds	Yes	Yes	Yes	Yes	Yes[x]	Yes	No
For large moulds	No	Yes	Yes	Yes	No	No	No
For small cores	No	Yes[x]	Yes	Yes[x]	Yes	Yes	Yes
For large cores	No	No	Yes	Yes	Yes	No	No
Re-use of sand	Yes	Yes	Some	Some	Some	No	No
Need for heat to cure	No	Yes	No	No	Yes	Yes	Yes
Accuracy and finish quality	Fair	Fair	Fair	Fair	Low	Good	Good
For serial production	Yes	No	Yes	Fair	Fair	Yes	Yes

[x] Possible, but not generally used

Table 29

FOUNDRY PATTERNS REQUIREMENT

Code No.	Description	Quantity	Imported	Locally made
01/18	Sprocket O 150 -	2		x
01/26	Linking part 200x150x150	2		x
01/29	Gear tooth O 130x30	2		x
01/11	Adapter O 20x150	10		x
02/3	Crushing balls O 60 - 90	6		x
012/3	Flanges 5" - 12"	20		x
012/9	Gate valves 5" - 12"	6 - 8	x	
012/10	Globe valve 5" - 12"	6 - 8	x	
01/22	Plate 650x300x60	1		x
01/12	Scariefier covers length 400 mm	1		x
02/1	Cooler plates 300x400x35	1 - 2	x	
02/2	Cement furnance plates 500x300x30	1 - 2		x

02/5	Standard threholds 440x440; 740x440	2 - 2		x
02/6	Tower chutes length 800	4		x
06/5	Excavator teeth length 500	6 - 8	x	x
03/7	Tooth gears O 100 - O 600	4		x
08/3	Mixer axles O 200 x 400	2	x	
08/4	Sprockets O 260	2		x
03/7	Tooth gear O 600	1		x
03/10	Engine cover 400x600x50	3		x
05/19	Cone 650x600x30	1		x
05/17	Gear O 650	1		x
05/1	Driving gear O 700	1		x

Table 30

MANPOWER REQUIREMENT

Description of post	Monthly salary/wages SYP	Pre-operational stage No	Stage I No	Stage II No
1	2	3	4	5
Manager PPF	12.000	1	1	1
Production Engineer	10.000	1	1	1
Laboratory/Quality Control Engineer	9.000	1	1	1
Chief Accountant	9.000		1	1
Maintenance Service/ Transportation Engineer	10.000	1	1	1
Chief Purchase/Sales/ Administration Section	9.000		1	1
Laboratory Staff				
Superintendent	8.000	1	1	1
Laboratory Assistant	6.000		4	10
Maintenance Services				
Mechanics	6.000	1	2	3
Electricians	6.000	1	2	3
Electronic Technician	6.000	1	1	2
Hammer Operator			1	1

1	2	3	4	5
Clerical staff	6.000	2	6	8
Process Design Section /incl. R/D activities/				
Senior Designer	7.000	1	1	1
Foundry Engineer	7.000	1	2	2
Mechanical Engineer	7.000	-	1	1
Technicians	6.000	-	2	3
Pattern-Making Section				
Production Superviser	7.000	1	1	1
Pattern-maker	6.000	2	3	4
Scrap-yard				
Skilled worker	6.000		2	2
Semi-skilled worker	4.000		2	3
Melting Section				
Superviser	7.000	1	1	2
Smelter	6.000	1	2	2
Pouring-in Stand				
Laddle operator	5.000		1	1
Mason	5.000		1	1

1	2	3	4	5
Moulding Section				
Moulding Machine Operator	5.000	1	6	6
Hand moulders	5.000	2	6	7
Production Supervisers	6.000	1	1	1
Sand Processing Section				
Operator of Sand Mixer Muller	5.000	1	1	3.
Core-Making Section				
Core-Maker	5.000	1	2	4
Cleaning/Felting Section				
Production Superviser	6.000	1	1	1
Cleaners/Operator of shot blast, cabinet etc.	5.000		3	6
Welder	6.000		1	3
Operators of heat-treatment owens	5.000		2	4
Fitter	5.000		2	2
Machining Section				
Superviser	6.000		1	1
Operators	5.000		2	3
Quality Control				
Inspector	8.000	1	1	1
Technician	6.000		1	2

1	2	3	4	5
<u>Transportation Section</u>				
Superviser	6.000		1	1
Drivers	5.000	1	2	3
Crane Operators	5.000		2	3
<u>General Services</u>				
Telephone Operator	5.000		1	1
Telex/Fax Operator	5.000		1	1
Store keeper	6.000		2	2
Watchman	4.000		3	3
Cleaners	3.000		2	2
Nurses	5.000		1	1
Librarian	6.000		1	1
Canteen Stuff	4.000		2	2
TOTAL		26	89	122